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The Prolonged Adolescence of  
Superconductivity: A subtle but  
powerful phenomenon remains  
to be exploited

Strip Mining: 200 tons is a big  
bite of coal—and of the land  
in which it lies

Edited at the  
Massachusetts Institute  
of Technology

# TechnologyReview



MARINE  
OIL  
POLLUTION  
CONTROL

# technology review

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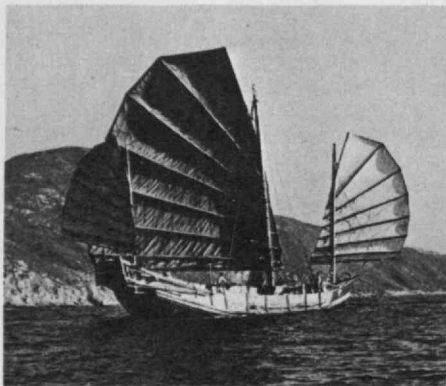
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## AEGEAN ADVENTURE

22 DAYS \$1429

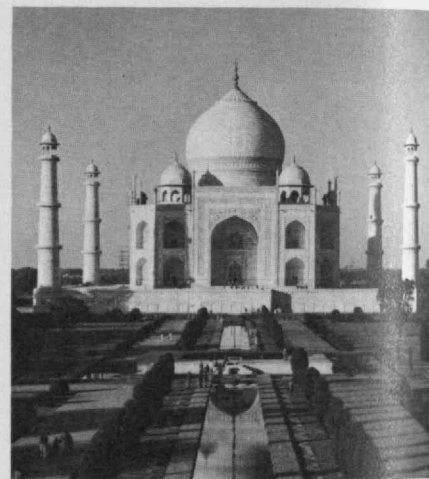
This original itinerary explores in depth the magnificent scenic, cultural and historic attractions of Greece, the Aegean, and Asia Minor—not only the major cities but also the less accessible sites of ancient cities which have figured so prominently in the history of western civilization, complemented by a cruise to the beautiful islands of the Aegean Sea. Rarely has such an exciting collection of names and places been assembled in a single itinerary—the classical city of ATHENS; the Byzantine and Ottoman splendor of ISTANBUL; the site of the oracle at DELPHI; the sanctuary and stadium at OLYMPIA, where the Olympic Games were first begun; the palace of Agamemnon at MYCENAE; the ruins of ancient TROY; the citadel of PERGAMUM; the marble city of EPHEBUS; the ruins of SARDIS in Lydia, where the royal mint of the wealthy Croesus has recently been unearthed; as well as CORINTH, EPIDAUROS, IZMIR (Smyrna) the BOSPORUS and DARDANELLES. The cruise through the beautiful waters of the Aegean will visit such famous islands as CRETE with the Palace of Knossos; RHODES, noted for its great Crusader castles; the windmills of picturesque MYKONOS; the sacred island of DELOS; and the charming islands of PATMOS and SANTORINI. Total cost is \$1429 from New York. Departures in April, May, July, August, September and October 1973.

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32 DAYS \$1995

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viceregal city of LIMA, founded by Pizarro, where one can still see Pizarro's mummy and visit the dread Court of the Inquisition; the ancient city of CUZCO, high in the Andes, with an excursion to the fabulous "lost city" of MACHU PICCHU; cosmopolitan BUENOS AIRES, with its wide streets and parks and its colorful waterfront district along the River Plate; the beautiful Argentine LAKE DISTRICT in the lower reaches of the Andes; the spectacular IGUAZU FALLS, on the mighty Parana River; the sun-drenched beaches, unforgettable mountains and magnificent harbor of RIO DE JANEIRO (considered by many the most beautiful city in the world); the ultra-modern new city of BRASILIA; and the fascination of the vast Amazon jungle, a thousand miles up river at MANAUS. Total cost is \$1995 from Miami, \$2080 from New York, with special rates from other cities. Optional pre and post tour visits to Panama and Venezuela are available at no additional air fare. Departures in January, February, April, May, July, September, October and November 1973.



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## EAST AFRICA

22 DAYS \$1739

A luxury "safari" to the great national parks and game reserves of East Africa, offering a breathtaking combination of wildlife and scenery: game viewing in the wilderness of Kenya's Northern Frontier district at SAMBURU RESERVE; a night at world-famous TREETOPS in the ABERDARE NATIONAL PARK; the spectacular masses of pink flamingos at LAKE NAKURU; multitudes of lion, zebra, wildebeest and other plains game in the MASAI-MARA RESERVE and the famed SERENGETI PLAINS; the great permanent concentrations of wildlife in the NGORONGORO CRATER; tree-climbing

lions along the shores of LAKE MANYARA in the Rift Valley; photographing rhino and other big game against the majestic snow-covered background of Mt. Kilimanjaro in the AMBOSELI RESERVE; and the vast and fascinating wilderness of TSAVO NATIONAL PARK, renowned for its elephant and lion and for the unusual desert phenomenon of the Mzima Springs. There is also a stay in NAIROBI, the most fascinating city in East Africa, as well as features such as a visit to a MASAI MANYATTA to see tribal dancing and the tribal way of life. The altitude in East Africa provides an unusually stimulating climate, with bright days and crisp evenings (frequently around a log fire), and the tour follows a realistic pace which ensures a full appreciation of the attractions visited. Total cost is \$1739 from New York. Optional extensions are available to the VICTORIA FALLS, on the mighty Zambezi River between Zambia and Rhodesia, to UGANDA, and to the historic attractions of ETHIOPIA. Departures in January, February, March, May, June, July, August, September, October, November and December 1973 (\$26 additional for departures in June, July and August).



## NORTH AFRICAN ADVENTURE

Preliminary Announcement

A new tour to North Africa and the regions which surround it, visiting GIBRALTAR, MOROCCO and the CANARY ISLANDS. GIBRALTAR, the gateway to North Africa, is the first stop, followed by a crossing of the narrow Strait of Gibraltar to TANGIER, on Morocco's northern coast. From Tangier, the tour proceeds by road to the imperial cities of MEKNES and FES, with an excursion to the Roman ruins of VOLUBILIS, then crosses the Atlas Mountains to the pre-Sahara and ERFOUD, on the edge of the desert. From here, the famed "casbah trail" leads through TINERHIR and OUARZAZATE to MARRAKECH, where an extended stay is provided before continuing to CASABLANCA. The visit to the CANARY ISLANDS, lying off the coast of Africa, will include stops in TENERIFE, the volcanic island of LANZEROTE, and LAS PALMAS. It is anticipated that the tour will be of three weeks' duration and that it will be inaugurated in the fall of 1973. Further details, including the tour cost, will be announced as soon as possible.



## MEDITERRANEAN ODYSSEY

Preliminary Announcement

An unusual blend of countries in the Mediterranean area, visiting TUNISIA, the Dalmatian Coast of YUGOSLAVIA, and MALTA. Starting in TUNIS, the tour explores the coast and interior of Tunisia: the ruins of the famed ancient city of CARTHAGE as well as the ruins of extensive Roman cities such as DOUGGA, SBEITLA, THUBURBO MAJUS and the magnificent amphitheater of EL DJEM, historic Arab towns and cities such as NABEUL, HAMMAMET, SOUSSE and KAIROUAN, the caves of the troglodytes at MATMATA, beautiful beaches at ZARZIS and on the "Isle of the Lotus Eaters" at DJERBA, and desert oases at GABES, TOZEUR and NEFTA. The beautiful Dalmatian Coast of Yugoslavia is represented by SPLIT, with its famous Palace of Diocletian, and the medieval walled city of DUBROVNIK, followed by the island of MALTA, with its treasure house of 17th and 18th century churches and palaces, where the Knights of St. John, driven from the Holy Land and from Rhodes, withstood the epic siege of the Turks and helped to decide the fate of Europe. It is anticipated that the tour will be of three weeks' duration and that it will be inaugurated in the fall of 1973. Further details, including the tour cost, will be announced as soon as possible.

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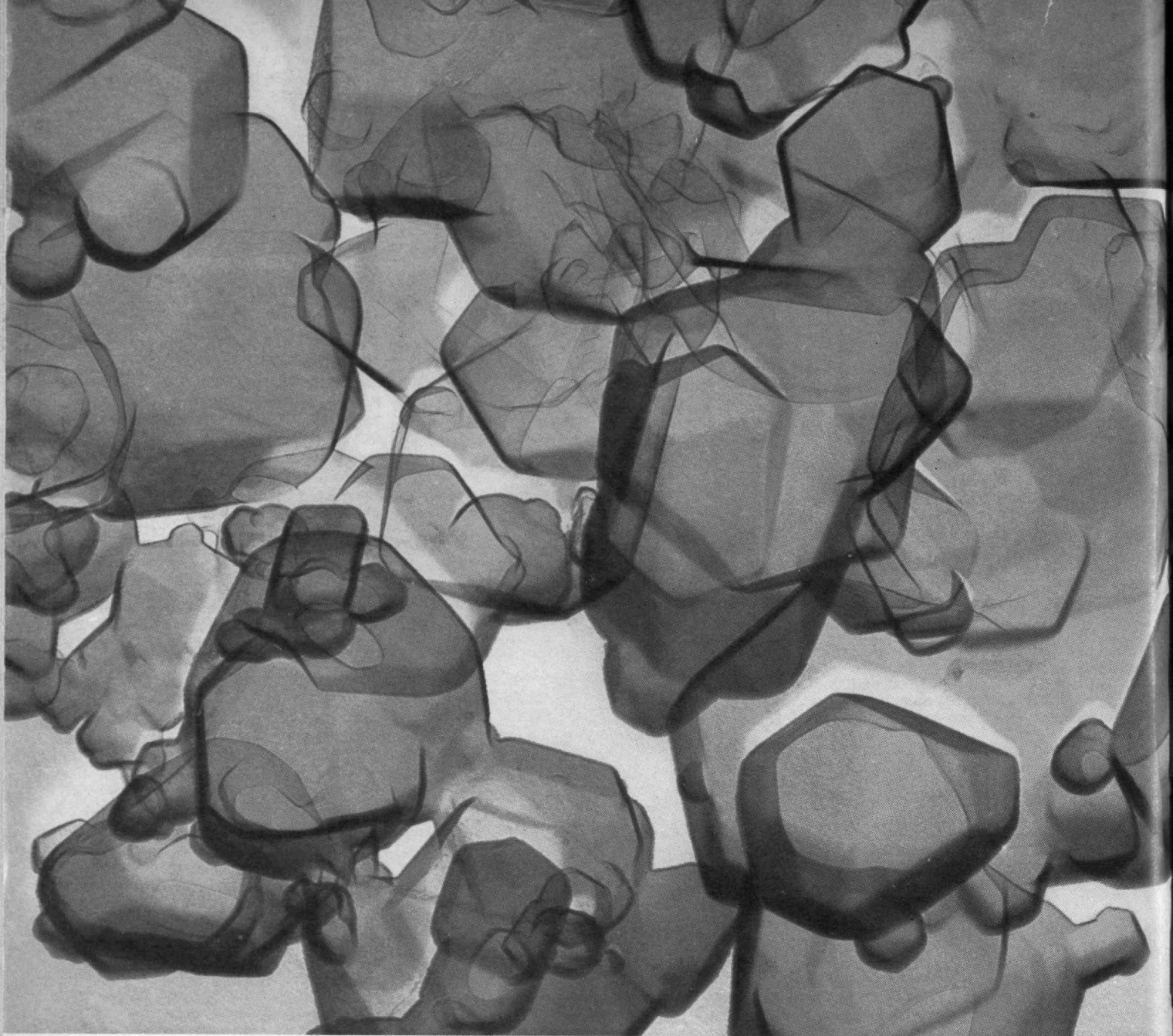
Rates include Jet Air, Deluxe Hotels, Most Meals, Sightseeing, Transfers, Tips and Taxes. Individual brochures on each tour are available, setting forth the detailed itinerary, hotels used, and other relevant information.

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## First Line

- The "Fusfeld Functions" Controversy**  
Alan R. Fusfeld's essay on quantifying the rate of technological progress (pp. 29-38) is an unusual article for this journal in at least two respects:

□ Mr. Fusfeld is a graduate student in M.I.T.'s Sloan School of Management, and it is all too seldom that work of such young contributors finds its way into the *Review*.

□ The editors have elected to present Mr. Fusfeld's argument in the same kind of mathematical terms in which it was originally presented to us. Some of us labor under the prejudice—perhaps uninformed—that many readers though fully able to cope with the intellectual exercise of a function such as

$T(i) = a^i b$   
are reluctant to make the effort in the context of a magazine such as this. Others of us were persuasive: the crucial point of the paper is a quantitative argument about a subject usually treated in qualitative terms, and the tools of mathematics are more than simply appropriate.

We always welcome readers' comments on *Technology Review*; this time we request them. As this is written, the "Fusfeld functions" debate continues. How much mathematics can you read?

### Erratum

The author has called our attention to an error in the chart on p. 46 of the January issue ("Alcohol: A Medicine and a Food," by Frederic W. Nordsiek). The scale is described as "ounces of alcohol"; but the chart is in fact drawn so that the horizontal scale is defined correctly as "ounces of 80-proof liquor." Our apologies to a patient and most understanding contributor.

Coming in our combined March/April issue:

## How to Manage Innovation

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## Letters

### Man-Powered Transport

Last winter I stopped utilizing the available transportation alternatives for masses of people (bus, subway trains, trains, air vehicles, gasoline-powered boats) and instead adopted new transport vehicles—the reasons for this change stemming from my desire to keep the external natural environment clean and unpolluted by noise, toxic gases, and space-devouring transport vehicles. The vehicles which I utilize at present, and desire to improve, are those that can either move under human power (bicycles) or with the aid of an environmental element—wind, sunlight, water (sailing boats, gliders, balloons).

Thus having little opportunity to move over distances greater than 500 miles by any vehicle except the 10-speed bicycle, I feel it necessary to learn as much as I can about this simple yet important structure of wheels, gears, and cables. Therefore, I want to work on several aspects of the bicycle which yet leave me unsatisfied, and potentially unprotected. I list them:

□ "A more effective braking system" such that I can ride in the rain and stop without dragging a foot on the ground.

□ Extra apparatus which would enable the cyclist to travel through the snow, or over a base of snow with sheet ice underneath. I thought about this and wondered whether any of these would solve the problem: chains, wider wheels, or wheels with regular dimensions and greater traction bumps.

Not a very extensive list. I wonder, also, about what possibilities velocipedes offer to transportation for more than two people per vehicle. Have people experimented with vehicles, propelled by human energy, that accommodated, say, ten persons?

Please let me in on any knowledge you or your readers possess on these matters.

Paul Rosenfeld  
Riverdale, N.Y.

### The Missing Link in Energy

It appears to me that in the discussion of the energy crisis (see "Energy for Millennium Three" by Earl Cook in Technology Review for December, 1972, pp. 16-23, and "Energy Resources to the Year 2000," Technology Review, January, 1972, \$1.95) you have presented only part of a total systems concept. The remaining part concerns the design of fuel-burning mechanisms. For example, throughout the United States the residential oil burners for heating purposes operate at a level of efficiency which suboptimizes efforts to preserve energy. This, I believe, is part of the missing link in the total systems concept. And I believe, further, that it is squarely a

matter of engineering concern relative to design and functional operations.

I realize that the cry of the engineer is that "nobody likes us"; but, truly, herein lies the problem of poor engineering design and engineering concern for environment and society. I am not concerned a bit with the typical engineering response with B.t.u. in and B.t.u. out.

Arthur L. Svenson  
Greensboro, N.C.

*The author is Professor of Economics and Business Administration at the University of North Carolina at Greensboro.*

### The Metric System and Trade Deficits

In his Washington Report (page 6, October/November), Victor Cohn discusses our slippage in high technology areas, enumerating our deficits in trade and knowhow, with comments from various public figures as to what action to take.

In none of this have I seen any mention of the impact of our refusal to date to adopt the metric system of weights and measures. It seems that every prominent country in the world has either already adopted the system or has made a commitment to do so, with the single exception of the United States. Early this year a metric conversion bill was sent to Congress by the Department of Commerce, as a result of a three-year study on the matter which had been authorized by Congress and had been completed in July, 1971. As I have read of nothing more on this bill, I judge it is stalled in some Congressional pigeonhole.

Some articles I have read, not necessarily in *Technology Review*, indicate that our lack to date of adopting the system is a serious impediment to our trade relationships and is a significant factor in our technology slippage internationally.

Lewis Blodgett, Jr.  
Asheville, N.C.

*Mr. Cohn responds: Of course the United States must move to the metric system, and I should have said so. I will try to comment on the status of this sometime in the future. At present there is no strong Congressional push, but this could change. The person who has pressed hardest is Senator Claiborne Pell.*

### S.A.L.T.: Political and Military Implications

Kosta Tsipis' article on "Strategic Stability, With S.A.L.T." (October/November, pp. 26-35) gives a seriously misleading appraisal of the strategic balance. Let me point out a few of the distortions it contains.

□ Tsipis treats the issue as a confrontation between two powers of similar character, each interested in its own security. That is not the political situation. The United States is a passive power which, while possessing overwhelming strategic weapons advantage, did not use its superiority for political expansion. The Soviet Union is an aggressive and expanding power which is intent on using superior military power for political advantage when gainful action is possible. It is dangerous to dissociate technical evaluation from political reality.

□ A basic premise of this thesis is that the Polaris-class submarine submerged is invulnerable. It may be invulnerable to targeting by land-based missiles, but it is highly vulnerable to attack by other submarines, not necessarily nuclear, which have speed enough to keep the Polaris submarine in range. The prospect that all our Polaris-class submarines could be destroyed in concert with an attack on our land-based missiles is not remote.

□ Tsipis argues that rough equality of offensive strategic weapons assures deterrence. But why live dangerously? If we want security for the world, why don't we build A.B.M.'s and dismantle offensive weapons so that neither side will have a capability of striking the other? This course would be acceptable to the United States. However, the Soviet Union insists upon building nuclear strategic weapons for potential political advantage and American negotiators are trying to rationalize acceptance of such "arms limitation."

□ Tsipis states that increasing strategic armament does not produce political advantage in "conflict with another nuclear power bent on countering these increases" (emphasis added). Precisely so, but what happens to the power which does not counter the increases? For eight years, the United States maintained a static position on nuclear armament while the Soviet Union built from 25 per cent of our strength (McNamara report to the Democratic National Convention, 1964) to 150 per cent of our power in the regulated weapons (S.A.L.T., 1972).

□ The S.A.L.T. agreements do not curtail Soviet missile building. As Tsipis pointed out, the U.S.S.R. had already curtailed its A.B.M. program and wanted us to conform. We did. Under the Executive Agreement, the Russians continue to build Yankee-class submarines for four more years, at which time they can simply end the S.A.L.T. talks and keep on building. We simply add four more years of building to the advantage the Soviets have in 1972. If it then takes us five years to tool up, as Kissinger estimates, the U.S.S.R. will have better than a two-to-one advantage when our assembly line begins to produce. This is calamitous neglect of national security.

□ By what logic does the United States allow the Soviet Union parity in strategic weapons? With the United States possessing twice the industrial capacity of the Soviet Union, simple insurance requires it to keep a decisively superior military posture.

□ S.A.L.T. is an ancient folly—the delusion that you can keep the peace through talk without power.

The S.A.L.T. agreements represent political action. Dr. Tsipis' piece is useful in presenting the shaky premises of these pacts offered by the Nixon administration. But it is not enough. You owe your readers a more comprehensive appraisal of the full political and security implications of these agreements.

Thomas A. Lane  
McLean, Va.

## Apollo: It's Been Fun—and More

Victor Cohn

"Science reporters," wrote my friend Victor McElheny in the December *Technology Review*, "do not cherish the old-style breathlessness about science; they feel their job can be done better without it. They are glad . . . to be freed from the latest ego-trip to the moon."

I demur. As a citizen, I am happy to see an end to the \$26 billion Project Apollo. As a friend of science, I feel that more science can be done in other ways for less money. But as a science-watcher, I am sad.

When were there more exciting moments in the whole history of science, and more vivid demonstrations of the thrill of discovery, with more participation by millions of persons? When I think of Apollo, I think of a circus at a time of war and inequality, and the fact that an American voyage to the moon was, in the cutting phrase of Komsomolskaya Pravda, "the most expensive experiment ever" in science and technology.

But I also think of the Apollo 11 astronauts emerging from their weird-looking craft and, by their first footsteps, establishing once and for all the solid if dusty nature of the lunar surface. I think of their rock collecting, which forced reporters and commentators by the hundreds to convey something about lunar geology and the possible history of earth, moon and planets. I think now of the final magnificent moments when geologist Harrison Schmitt, in one of the greatest single finds of the entire project, bent over a band of orange soil and said "If there was ever anything that looked like a fumarole"—a volcanic vent—"this is it." At last, and shamefully late, after 27 manned U. S. flights and the \$26 billion Apollo budget, one bona fide field scientist had made it up there!

A field scientist—this is my point. Scientific advance is not often the fruit of a sudden flash of insight or discovery. It is more often the result of endless plodding and piling factual bit on bit and somehow making sense of the whole in the way of a Copernicus or a Darwin or a Einstein. Geochemists and others must work over the Apollo 11, 12, 14, 15, 16 and 17 lunar materials for years, until the Copernican insight at last emerges. This is a long and beautiful process, one described all too little and one that science reporters should eternally attempt to convey if they would convey the essence of natural investigation.

At the same time, the sudden flashes and surprises and dramatic discoveries do occur: the orange soil of Apollo 17 and the 3½-billion-year-old rocks of Apollo 11, dated within four or five weeks of the day on which they were picked up on the moon.

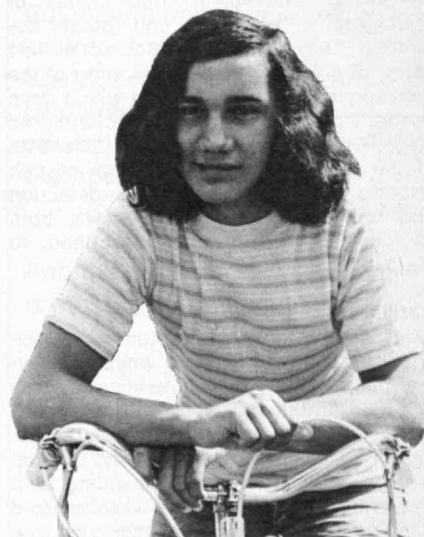
## Bob Cree came to Northfield Mount Hermon and found the beginning of a Third Way.

Bob is Mohawk. Though he still feels a mystical oneness with his land, he knows there is no way back to the time of the legends.

Yet being Mohawk is very important to Bob and he intends to remain a Mohawk. He and the dozen other members of various tribes at Northfield Mount Hermon came here to find a Third Way . . . a way somewhere between the ancient way and the way of merely aping the white man.

His is youth's predicament—between accepting what can't be changed and working for what can and ought to be. He'll work for that at Dartmouth.

Bob is perhaps a little more concerned than the average youngster today. We think it's likely that most Northfield Mount Hermon students are. It's that kind of place.



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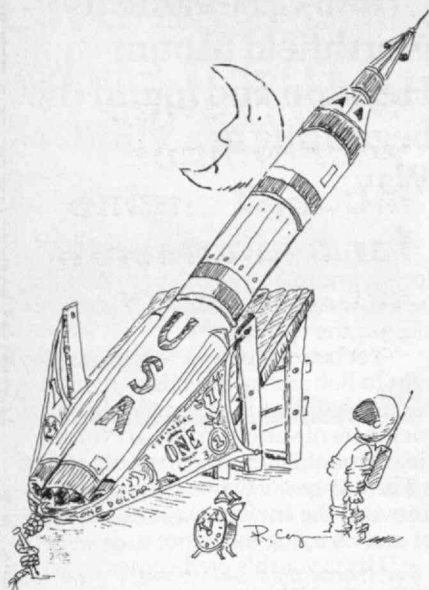
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**"After 27 manned U.S. flights and the \$26 billion Apollo budget, one bona fide scientist had made it up there."**

I remember the opening of the International Geophysical Year on July 1, 1957. I was working in Minneapolis. University of Minnesota physicists sent up a series of plastic balloons bearing stacks of photographic emulsion and other detectors. They promptly detected a vast storm of solar particles at the edge of the atmosphere, 20 miles up, and within days—after poring over the photographic plates—were informing world scientists of the existence in such storms of rich streams of solar protons. The detection and the interpretation were news, both to scientists and, properly described, to the public.

#### Getting Us Out Of the Press Room

What greater reward and fun for a science writer than watching physicists flying balloons like Ben Franklin flew his kite, and, in the very opening hours of an unprecedented international scientific endeavor, making a discovery? What greater fun and reward than sitting at a typewriter, watching a TV monitor and listening through headphones as the Apollo 11 astronauts climbed out of their space buggy and put foot to moon and within moments were describing "vesicular" rocks, a term they and I had learned in the same N.A.S.A. rock lab?

A science reporter on that night had to write his copy like a police reporter or any other newsman amid deadlines, not in long, considered exposition but in "takes," "ads," "inserts," "new leads," all the code words by which news stories get assembled or misassembled, and a manner in which science reporters, like all other reporters, must often work.

For better or worse, there is no other way to get out a news report, and there is no other way to report science on those occasions when it is news. In my view, there is also no better way to capture an audience for scientific discovery, while

painstakingly telling that audience that these are special if far from unknown moments, and that the process of discovery is also lengthy and cerebral.

Perhaps we who report science, and complain a bit these days that public interest in science is lessened, need to get out more often with the field scientists and experimenters—the oceanographers, the biologists in Chesapeake Bay studying marine populations, the astronomers at their telescopes and electronic arrays, the experimental physicists at their bubble chambers and accelerators.

On the occasions when scientists are excited by discovery—and this happens; just listen to scientists talk—we should also be, and perhaps dash for a telephone.

#### Knowledge We'd Barely Hoped For

This is how I, at least, feel as part of my personal requiem for Project Apollo. The project, of course, was not a scientific one. The objective of President John F. Kennedy, when he set the course in 1961, was simply to get an American on the moon in the decade. This we did.

By the time we did it, it seemed much less urgent. To a president, however, faced with growing U.S.-Soviet competition in every arena, confronted then with the embarrassing fact of Soviet manned space superiority and smarting at the time from the Bay of Pigs debacle, getting Americans to the moon was a politically attractive goal. At the time, most Americans agreed with him.

N.A.S.A. did this basic job with huge skill and, despite setbacks, brought it in, at the time of Apollo 11, for the projected \$20 billion or so estimated cost, with no big overruns. Money was added to fly additional moon missions; several vehicles had been built, partly because until the first landing no one knew how difficult it might be. "Prior to landing" Apollo Program Director Rocco A. Petrone recently told the *Washington Post's* Tom O'Toole, "there wasn't one man in the program who didn't think we were going to have to abort at least one or two landing attempts."

The landings never became easy; if they seemed that way, it was only because the preparation was so excellent. Behind every astronaut stood thousands of engineers, mathematicians, scientists, and aeronautical workers; N.A.S.A. says that 415,000 men and women contributed to Apollo, not counting news reporters.

It was certainly not a predominantly scientific project before the last group of flights; the decision to make these final missions had to be based in large part on the desirability of doing scientific exploration, since the landing capability had by then been demonstrated. Yet even here it would be hard to say that President Nixon supported a continuing program for science.

#### Pick a Ball, a Fragile Ball

To the country's leaders this was well worth a few extra billion as a continuing demonstration to the world of American strength, as well as an event in which Americans of all varieties could take interest and pride, despite the growing feeling that we had better direct our billions

toward problems here on earth.

The Apollo flights also helped keep the aerospace industry going, as will the coming manned space ventures: Skylab (1973-74); Soyuz, which involves both the U.S. and U.S.S.R. (1975); and the reusable space shuttle (late 1970s, providing Congress votes the money). All will be on a much smaller scale than Apollo, which demonstrated that man can do more in space than some robots and instruments, but also demonstrated that the cost of keeping him there is too great for the payoff, given current competing demands on the national budget.

N.A.S.A. wanted to expand the shuttle to travel to a huge space station. It is not on the list and not likely to get there in the near future. The shuttle is there because, in the opinion of high-quality scientific advisers to the President and the Office of Management and Budget, it is the most economical, most sensible way to go if you want to maintain a manned space capability. It is not there because any large number of either scientists or administration officials are convinced that there is a long list of essential functions for man in space at this point in history, though there will be much hoopla about the "irreplaceable" earth observations and astronomical chores performed by the astronauts aboard Skylab.

What did Apollo accomplish? It is in truth teaching man far more about the moon (hence the solar system, hence the universe) than he could have learned from instrumented flights, although it was not the scientists, for the most part, who pressed for manned exploration.

Apollo did demonstrate America's and man's technological strength in a way that cannot help but inspire all future technological planners, even though planning earth systems is many times as complex because there are human beings in the way.

Apollo was indeed a rare human adventure. And that distant view of the tiny earth—described again and again by the astronauts and seen by us all—may indeed sink into man's consciousness with powerful results.

Copernicus taught man that the earth was not a central body, and this had profound effect on man's view of himself and the universe. Apollo showed man that the earth is merely a round ball, circumscribed, fragile. This too is a profound message, but we who are alive will not know future man's reaction.

*Victor Cohn, who writes regularly for Technology Review, is Science Writer for the Washington Post.*

## Great Accidental Endowment

**Victor K. McElheny**

The sixth and last lunar landing by Apollo astronauts ended what amounted to a single giant scientific expedition—

the first to another planet. Now comes the longer and more intellectually demanding interpretation of the discoveries.

The Apollo expedition to the moon was a little shorter than the five-year voyage of the Beagle, a little longer than Scott's first expedition to Antarctica in 1901-1904, and about the same length of the voyage of the Challenger, which set out from Portsmouth in December 1872 on a cruise which can be regarded as the foundation of oceanography.

The scientific politics of the 3.5-year Apollo expedition was far more intense than for earlier expeditions—largely because of the enormous expense and publicity—but the issues were the same. The expedition was still only as good as the original planning and the capacity for intellectual growth of the expedition members (most of whom remained behind on Earth).

Early in the expedition old ideas had to bow before incontrovertible data pointing to a moon that might have been captured—perhaps from the vicinity of Mercury—but certainly was not ripped from Earth nor simultaneously shaped near the forming Earth. The moon's chemistry showed no sign of water or of life. Yet, for the first 1.5 billion years of lunar history, the little planet underwent titanic episodes of melting and sorting, a volcanic dynamism which appears to have ceased about the time life originated on Earth.

However, the extraordinary collections of samples on both lowland and highland sites within a limited distance of the equator on the moon's front side, the emplacement of five long-lived planetological observatories, and the orbiting of three chemical surveys occurred in such rapid order that the results of the early flights had little impact on subsequent missions. Only the choice of the Taurus-Littrow site visited by Apollo 17, combining highland material with what appeared to be relatively young volcanic rock, was based on theories elaborated since Apollo 11 that began overturning established ideas about the origin and history of the moon—and, by extension, of all planets.

Now that the Apollo missions have ceased, the world's little community of lunar scientists, about 1000 in all, look forward to deeper study of the rock and soil samples, and to a continuing flow of information from the instruments on the surface. Seismologists in particular pray for long life for the instruments, and for many more large meteorite impacts like the farside event of last July 17 that sent signals through the moon to the frontside stations hinting at a still-molten core.

#### Special Case

The only lunar rocket flight the scientists really look forward to now is an unmanned craft, equipped with a subsatellite, which would go into polar orbit and extend the chemical surveys to the entire surface. The scientists know they will have to fight hard to get it, partly because of a mistaken idea that even the purely scientific part of Apollo has been enormously expensive. It turns out

that the entire cost of lunar science on six successful and one aborted Apollo missions was \$400 million, including \$190 million for the surface stations and \$67 million for three orbital survey packages.

By comparison the combined cost of the big particle accelerators at Stanford, Calif., and Batavia, Ill., is about \$400 million. The Viking program for putting a pair of landers on the surface of Mars in 1976 has an estimated "run out" cost of \$830 million. The Orbiting Astronomical Observatory program for studying ultraviolet sources in the heavens has cost \$360 million. Even the Apollo Telescope Mount for observing the sun from the Earth-orbiting manned Skylab to be launched in April will cost \$200 million, more than all the lunar surface observatories put together.

The polar-orbiting, remote-sensing, lunar mission would cost about \$50 million. The lunar scientists consider it far more important than any further unmanned surveyor soft-landers or even the Soviets' simple, automated, sample-return craft which have brought back small tubes of material from one lowland and one highland site. Of greater interest would be a Soviet effort to combine a roving cart like that of Luna 17 with a sample return craft. This would allow detailed unmanned exploration of a site.

The scientists certainly are not repining for an immediate resumption of manned journeys to the moon, although they praise the magnificent achievements of the Apollo crews and the intense, generous cooperation of N.A.S.A. managers once thought hostile to lunar science. They do not think of the detailed work before them as laying the groundwork for a return to the moon. One scientist felt that the rocketeer Wernher von Braun was looking into a "cracked crystal ball" when he forecast an era of men roaming the moon in pressurized cars.

The point is that the moon is merely a special case in the science of planets. The first men went into orbit around the moon Dec. 24, 1968, and the last three Apollo explorers left lunar orbit Dec. 16, 1972. In that same period, two unmanned Mariner craft flew by Mars and a third went into orbit, taking pictures and many other measurements for 11 months. A Pioneer survey craft took off for Jupiter early in 1972 and will pass by that fizzled star this Christmas. A similar craft will leave this year, to arrive at Christmas 1974. This fall another vehicle will be launched to bypass Venus in February 1974 and swing into a double bypass of Mercury in March and September 1974.

When the moon's contribution to the science of planets is assessed in a decade or so, further lunar exploration will have to be weighed against studies of other planets, which by then may have more to tell us about the nature of our own planet. To be sure, many of the questions to be asked then about Mars or Mercury or Venus or the large moons of Jupiter or Saturn will have been influenced by lunar studies. But they also will have been formed by increasingly intense studies of meteorites like the one, unusually rich in calcium

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and aluminum, that fell at Allende, Mexico, just before Apollo 11.

### Remarkable Compression

There is an astonishing disproportion between the \$25 billion cost of staging the Apollo lunar landings and what it will take to exploit fully the scientific riches that have been brought back. About \$10 million a year for 10 years should do it. That would about equal the operations cost of a single Apollo mission. About \$2 million a year will be needed to monitor the stations on the moon. Another \$7 million a year would go for grants to the highly specialized laboratories in the U.S. and a score of other countries for studying lunar samples.

The rest of the money is needed for proper storage and cataloguing of lunar samples, laboratories at the Manned Spacecraft Center in Houston, Texas, and a modicum of effort toward planning future manned and unmanned lunar missions.

The planning for the six Apollo landings largely represented the best scientific guesswork of the period before 1969, when the Apollo system for landing men in a zone between 30 degrees north and south of the lunar equator, and between 30 degrees east and west longitude, achieved an unexpectedly early success.

In the aftermath of the splendid scientific success of the subsequent Apollo landings it is well to remember how much of an accident they were.

To be sure, the landings could hardly have occurred much sooner than a century after Jules Verne had imagined them, but they were made in the name

of political and military prestige, an assertion of American positivism. They were not planned in the name of science. A purely scientific program of exploration could not have won sustained acceptance from Congress, which was balky enough as it was. Anyway, the scientific community constantly decried the immense sums spent as a kind of deliberate starvation of other branches of science.

To assure success in the grandest Olympic race of them all, the American moon program was endowed with a large stock of Saturn rockets and Apollo space ships and lunar landers. After all, it might have taken as many as three earth-orbital tours to get the bugs out of the conical command module and its attached cylindrical service module. Perhaps several manned tests of the lunar lander would be needed before the craft could be trusted to safely deposit a pair of astronauts on the moon's surface.

It all went more smoothly than expected. There was a remarkable compression of test flights, erasing perhaps all the time lost through redesigns after a launch pad fire killed three astronauts in January 1967. Only one earth-orbital bus ride, Apollo 7 in October 1968, was necessary for the command and service modules. Because of unusually swift and complete analyses of serious problems on the second unmanned test of the Saturn V rocket, only two tests were needed instead of three. The very first manned Saturn V flight put men into orbit around the moon on Apollo 8. Just one unmanned earth-orbital test of the lunar module, Apollo 5, and one manned test

on Apollo 9, were needed, opening the way to a lunar-orbit test on Apollo 10 that could have been a landing.

The process went so fast that a special "early Apollo" scientific station had to be prepared for a possible landing on Apollo 11. What a debt science owes to the compulsive excellence of American space engineers!

The landing was a complete success. It occurred during the earliest possible mission in the Apollo series. Yet, the success created acute embarrassment for both the space agency and the scientific community.

### Yes, Yes, Yes

The heart of the space agency belongs to machines that men fly. All else is secondary. The success of Apollo 11 left the space agency with a stock of nine Saturn V rockets, developed at a cost of \$7 billion, suitable for little else besides achieving the national goal of a safe round trip to the moon before the Russians and before 1970. The idea of placing a fully-equipped, 100-ton Skylab in space with a Saturn V did not win approval until late 1969 (there was a whole flock of smaller Saturns available for getting the shell of the lab and successive crews and supplies up there).

It would be some years before the Skylab was ready. And more years after that before a two-stage reusable rocket shuttle would be developed to regularize manned travel into and back from space. Meanwhile, continued moon voyages would keep men flying and keep the adventure of manned space flight before the public until the next flying machine came along.

For the scientific community, the success of Apollo 11 was even more embarrassing. Most scientists had discounted the affair from the beginning. Some scientists who had worked with N.A.S.A. on planning the lunar landings were so exasperated by what they regarded as continued downgrading that they left in high dudgeon.

They in fact left at the moment of victory. A completely new team of scientist-managers had to be found to deal with the situation. And what a situation! The rocks from Apollo 11 were blasting established ideas right and left. N.A.S.A. was stepping forward with enough rockets and spacecraft and pilots for perhaps nine more landings. It could be considered the most stupendous accidental endowment for scientific research ever.

Because of the immense cost of operating the Apollo system of launch pads, crew training, mission planning, and mission-controlling, the success had to be exploited quickly by the space engineers and the scientists who had found a sudden need for each other's contributions.

Plans were made to land three more mooncraft like that of Apollo 11, each to carry a geophysical station and enough equipment for two outdoor rock-collecting excursions.

Beyond that, a more ambitious stage of exploration was to begin. This would involve slightly heavier mooncraft equipped for three days on the surface, a tele-

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vision-equipped car for mobility at the site, suits equipped for three seven-hour moonwalks, and a package of orbital remote-sensing instruments.

The second phase was ready in less than two years, at a relatively tiny cost. The moon-cars cost \$38 million for three.

The plans for the experiments to be placed on the surface and carried in orbit during the extended J-missions were made in December 1969, before the Houston conference disclosed the Apollo 11 results. A total of five of the extended missions was envisaged.

But then in September 1970, N.A.S.A. saw that it would have to operate into the indefinite future on a budget fixed at \$3.25 billion a year, and with a national labor force of about 120,000. The agency reached for the billion-dollar saving of canceling two lunar missions.

With only three missions to go, N.A.S.A. was left with what it regarded as an acute problem of fairness to the scientists who had begun developing experiments for the now-cancelled Apollos 18 and 19. There was a surface electrical properties experiment for use during astronaut traverses; a gravity experiment for inclusion in a surface station; and an ultraviolet lunar-atmosphere probe, an infrared scanner, and a radar probe to look for subsurface water, all intended for orbital packages. It was decided, with little overt scientific opposition, to fly all these experiments once, on Apollo 17.

This happened even though a more conservative scientific judgment might have opted for yet another passive seismic station on the surface and a third gamma ray and x-ray survey from orbit.

Few foresaw when the decisions were made that the splendid success of the seismic network or of the Apollo 15 and 16 chemical surveys would make the ambitious new experiments of Apollo 17 appear marginal. There was serious questioning of whether the American tendency to say yes had been carried too far. But it was the same tendency that created the stupendous scientific opportunity of the Apollo program in the first place.

*Victor K. McElheny, formerly European correspondent of Science and Science Editor of the Boston Globe, is a freelance writer based in Cambridge, Mass.*

## Reflections on the Launch of Apollo 17

**Albert H. Teich**

I have always had a certain ambivalence about the Apollo Project. Basically, I find the notion that man has actually begun to explore outer space during my lifetime enormously exciting. On the other hand, I cannot help being affected by the stark contrast between the ease with which we have spent billions of dollars on the space program and the

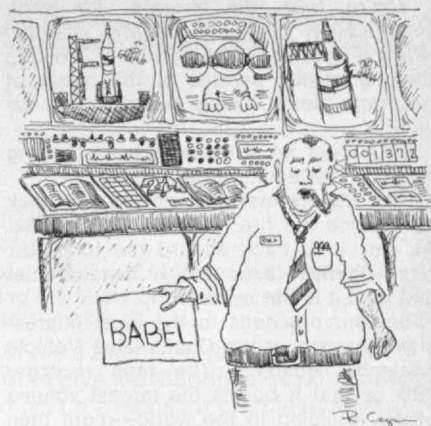
difficulty we have in allocating much smaller amounts to the solution of earth-bound social problems. Recently, however, when presented with the opportunity to witness the launch of Apollo 17 first-hand, and when I realized that this would probably be my last chance for many years to see a manned moon-shot, the temptation proved too much to resist and I allowed myself the indulgence of becoming, temporarily, a full-fledged "space-buff."

Years of watching manned space flights through the eyes of Walter Cronkite had helped to prepare me for the drama and spectacle of the lift-off itself. I was quite unprepared, however, for the intensity of the experience in which I found myself involved for the 30-odd hours I spent at Cape Kennedy prior to the launch. Perhaps there is an intellectual lesson to be learned from this experience. Certainly, I returned home with a wealth of new and interesting information. I think, though, that there may be as much to be gained from dealing with the events on an emotional non-intellectual level—in the manner Norman Mailer conceived his unique account *Of a Fire on the Moon*—rather than in a strictly analytical vein. Hence, I find myself relating to the whole affair experientially and sensually, more or less in the way one relates to the experience of getting to know a symphony, a magnificent landscape, or a work of art.

### Launch Sites

Arriving in Cocoa Beach on the evening before launch day, I immediately discover an aspect of the Cape Kennedy scene seldom reflected in media accounts: the tradition of pre-launch partying. Despite the decentralized layout of the town, several corporate parties are easily located—even by those who, like myself, don't happen to be invited. Perhaps these affairs are, as some say, less lavish than the bashes of the earlier Apollo launches, when money flowed more freely in the space technology community. But, tonight's hosts are still hardly cheapskates. North American Rockwell offers free dinner (cafeteria style) and drinks at the Holiday Inn and seems to attract mostly aerospace executives, as well as a variety of tired Miami call-girls. The party never seems to develop any real spirit.

Time-Life erects a large tent by the beach, hires a steel band, and cooks up a huge luau, serving generous drinks, fresh pineapple and thick slices of rare roast beef. They do much better in gathering celebrities. Astronauts Wally Schirra, Alan Shepard, James Irwin, Rusty Schweickart, Deke Slayton, and Buzz Aldrin—obviously social lions—are easily spotted. Each is holding court before at least five attractive young female admirers. Most have gone somewhat mod; but Aldrin is positively hip—he's sporting longish hair, a full beard, a maroon turtleneck, and a couple of silver medallions around his neck. Henry Mancini and Hugh O'Brian are in attendance, attracting some attention. (What are they doing here?) But, the star of the evening is clearly Walter Cronkite, whose genuine excitement at the prospect of seeing



..ALRIGHT !... WHO PUT THIS  
SIGN ON THE LAUNCH TOWER?

**"The steamy heat and the constant din soon become tiresome and I leave the party scene..."**

another launch is infectious. Dressed in a yachting-style outfit, Cronkite is all smiles as he greets colleagues, old friends, and numerous fans and autograph seekers.

The steamy heat and the constant din soon become tiresome and I leave the party scene in order to visit the launch site for a quick preview of the main attraction. In the midnight darkness, the brilliantly lit Saturn V rocket is truly an awesome sight. The press area, 3-1/2 miles away from the launch pad, is totally deserted, save for a couple of Boeing guards. Absorbed in gazing at the rocket, I am startled by something darting across the barely-lit grass a few feet in front of me. It is, of all things, an armadillo—and I am struck by the incongruity. Nothing unusual, one of the guards assures me. In addition to being a spaceport, Cape Kennedy is a wildlife sanctuary. Armadillos, alligators, snakes, and egrets share the swampy turf with Centaurs, Titans, and Saturns.

### First Time Since the Fire

The Kennedy Space Center is closed to the public on launch day. The TWA-operated visitor center and the Greyhound-operated bus tours, normally available to all tourists, are reserved this day for V.I.P. guests. The buses, complete with tape-recorded commentaries, carry the guests on a two-hour circuit, which includes the sites of the first Mercury launches, and the field where the Apollo astronauts practiced driving the lunar rover.

My bus stops at Launch Complex 34. Here, the guide explains, Astronauts Gus Grissom, Ed White, and Roger Chaffee died in the Apollo spacecraft fire of January 1967. The facilities, which were used in several early Apollo flights, are now being dismantled and sold for scrap. One of the V.I.P. tourists, a tall, elderly man of imposing mien, spotting my press badge, comes over to me and introduces

himself.

"You're from the press?" he asks, rhetorically. "We're Mr. and Mrs. Chaffee, Roger's parents." The notion of meeting the astronaut's parents at the scene of his tragic death leaves me at a loss for words.

"This must be a rather strange feeling for you," I attempt, rather meekly.

"Yes, it's the first time we've been back here since the fire," replies Mr. Chaffee. As we climb back aboard the tour bus, Mrs. Chaffee takes out a handkerchief and puts it to her eyes.

The tour proceeds to the most impressive structure at the Center—the Vehicle Assembly Building. The tape recorder tells us that it boasts the largest volume of any building in the world—more than the combined total of the Pentagon and the Merchandise Mart. Elsewhere, its exterior has been described as one of N.A.S.A.'s less attractive contributions to world architecture. Inside, however, it is different. Despite all of its functional austerity, to me it resembles nothing so much as the interior of a great medieval European cathedral. Lighting is subdued. The mammoth cranes and girders seem to form vast Gothic arches. The translucent yellow windows, 40 stories high, bear an eerie resemblance to stained glass. The building even seems to be laid out in the shape of a cross. The V.A.B. is definitely a cathedral; it is where man comes to express his faith in servoactuators and multiplexers, in liquid oxygen and liquid hydrogen.

#### Clawing at the Window

"Astronaut egress" seems to stir little excitement among the press at Apollo 17. This, in typically sterile N.A.S.A. jargon, is the well-worn scene, several hours before launch, in which the astronauts emerge from the building where they have donned their space suits and board the van for the seven-mile ride to the launch pad. The crowd here is relatively sparse, but, for the first time in the history of the program, it includes astronauts' wives and children. (Mrs. Eugene Cernan, Mrs. Ronald Evans, and their children have flown in from Houston. The third astronaut, Harrison Schmitt, is a bachelor.) Eleven-year-old Jon Evans is standing next to me. Evidently very nervous, he is desperately trying to look calm. (How can one comprehend the feelings of an 11-year-old boy whose father is about to leave for the moon?)

The astronauts finally "egress." They wave, hug and kiss their wives through their helmets, and mount the van through its back door. Suddenly, just as a technician is about to shut the door behind him, Schmitt—the first scientist-astronaut to gain a flight assignment—starts to step back out of the van. At first everyone is aghast. Then, as Schmitt's intent becomes clear, everyone breaks up into laughter. "The Reluctant Astronaut." Shades of Don Knotts and Bill Dana. The door closes. Grinning and obviously pleased with his little ploy, Schmitt pretends to clav: at the rear window as the van begins to move away.

At T minus 90 minutes, the press is invited to visit the V.I.P. grandstand to catch glimpses of the celebrity guests.

Actually, most of the "V.I.P.s" at the launch are ordinary people who have managed to obtain an invitation through a connection with a contractor, a congressman, a N.A.S.A. official, or some such source. No doubt, many had their sense of self-importance somewhat deflated when they discovered that they were among no fewer than 40,000 invited guests. Quite a few of these "V.I.P.s" seem to be spending their time pushing at the restraining ropes, trying to catch a glimpse of some of the "V.V.I.P.s" seated in the special reserved grandstands. These "V.V.I.P.s" include such notables as Johnny Carson, Bob Hope, Don Rickles, John Wayne, Governor George Wallace, Eva Gabor, and Secretary of H.U.D., George Romney. Connie Stevens is being interviewed by a woman reporter standing near me. The reporter seems to be doing most of the talking. I catch Miss Stevens' attention and ask her if she would ever like to go to the moon.

"Oh yes," she replies quickly. Then she grabs my arm and adds, "But only if they let me take my children with me." I assure her that this is a reasonable request, and suggest that she only pay half-fare for them.

#### The World Stops

At T minus 30 minutes, I return to the press area. The countdown proceeds; the tension builds among the nearly 4,000 reporters. These are not ordinary reporters on an average story; they, too, are "space buffs." Suddenly, at T minus 30 seconds, the world stops. Silence reigns. The agonizing minutes, then hours, pass. Reporters' spirits rise and fall with the ambiguous signals from mission control. N.A.S.A. has perfected the technique of making important sounding announcements that add little or nothing to what one knows.

During this interval, I place a call to my wife who is at home watching the launch coverage on television. I am struck by the contrast in our perspectives. She has the latest facts and figures on her mind: launch windows, recycling times, etc. I am absorbed in a continuing flow of perceptions and emotions. She is watching the launch. I am living it.

Finally, after midnight, the countdown resumes. An audible sigh of relief issues from the intensely involved crowd as each milestone in the count is passed. Finally, a small orange glow is seen, and quickly the whole sky begins to light up as the first-stage engines ignite. The giant rocket rests on its ball of flame for an eternity, it seems, before it begins to move. Then, with incredible slowness, it rises—and only as it is doing so, 15 seconds after ignition, does one begin to feel the impact of the sound and vibration. The feeling is literally indescribable. The ground shakes and one is engulfed in sound. The day-like brightness of the scene begins to fade as the orange flame grows smaller. Soon, the second stage has separated and the spacecraft disappears from view. Six hours ago, three men walked past me—not more than 10 feet away. Now, they are on their way to the moon.

Albert H. Teich is Director of Science and

Technology Studies at the Policy Institute of the Syracuse University Research Corporation. He holds degrees from M.I.T. in physics (S.B. 1964) and political science (Ph.D. 1969).

## Tom Lehrer at Home In the U.S.S.R.?

#### Book Review

Robert M. Solow,  
Professor of Economics, M.I.T.

#### The Spoils of Progress: Environmental Pollution in the Soviet Union

Marshall I. Goldman

The M.I.T. Press, Cambridge, Mass. and London, 1972, 372 + xi pp., \$7.95

The Polish joke says that capitalism is the oppression of man by man, and socialism is just the opposite. That, then, is an example of one of the differences between capitalism and socialism. Professor Marshall I. Goldman of Wellesley College, who is a specialist both in environmental economics and in the economy of the Soviet Union, has written a fascinating book about one of the similarities: once they reach a certain level of industrial production and urban population density, both capitalist and socialist economies seem to disrupt the natural environment more than is necessary or desirable, and both seem to find it much easier to give lip service to the environmental cause than actually to mend their ways, or their air, or their water.

Most of Professor Goldman's book is a documented account of some of the major cases of environmental deterioration in the Soviet Union and of sporadic, usually fruitless, attempts to repair them. There is a sad chapter describing the pollution of Lake Baikal in Siberia—the oldest, largest, deepest fresh-water lake in the world, with exceptionally clear, pure water and some 700 species of living organisms all its own—by the pulp and cellulose plants and the logging operations of the Cellulose, Paper, and Carton Administration of the Ministry of Timber, Paper, and Woodworking. Another chapter tells how the diversion of the Volga, Syr Darya, and Amu Darya rivers for the worthwhile purposes of navigation, power generation, and irrigation have diminished the flow into the Aral and Caspian Seas, reduced their surface area by about 10 per cent since the late 1930s, increased the salinity of the water, reduced the fish catch, and encouraged a rise in the mosquito population.

Tom Lehrer would be right at home in Moscow. ("Don't drink the water, and don't breathe the air.") The ancient pine trees in Izmailovskii Park have no choice; their annual growth fell by 70 to 90 per cent, depending on age, after 1930. For people, Moscow has sulfur oxides, suspended particles, and smog. There have been recent attempts to move the

Continued on page 70

# Penetrating Studies of Terrestrial Strata

## PRINCIPLES OF CHEMICAL SEDIMENTOLOGY

Robert Berner, Yale University / *International Series in the Earth and Planetary Sciences*  
1971, 240 pages, (004928-9), \$14.50

No other book is specifically devoted to the applications of physical chemistry to the study of sediments and sedimentary rocks. Fundamental principles of chemical thermodynamics and kinetics, as they pertain to low temperature geochemical processes, are presented and utilized throughout the discussion of important sedimentological problems. Thus, the book illustrates how sediments and associated waters are studied from a physicochemical viewpoint. Suitable for courses in petrology, geochemistry, environmental science, sedimentology, and oceanography. "For the practicing scientist and the advanced student of low-temperature geochemistry, *Principles of Chemical Sedimentology* is required reading." – Donald D. Runnells (Dept. of Geological Sciences, University of Colorado, Boulder) in *Science*, Vol. 175, January 28, 1972.

## ORE PETROLOGY

R.L. Stanton, University of New England, Australia / *International Series in the Earth and Planetary Sciences*  
1972, 672 pages, (060843-1), \$19.50

Examining the mineralogy and petrology of ores, this text deals with the nature and genesis of the deposits in which they appear. The ores are viewed as natural polycrystalline aggregates, and their physical and chemical features are therefore considered from the point of view of modern materials science. Many of their properties are shown to be analogous to those developed by grain growth, deformation, and annealing in industrial metals and ceramics.

## PETROLOGY OF IGNEOUS AND METAMORPHIC ROCKS

Donald W. Hyndman, University of Montana / *International Series in the Earth and Planetary Sciences*  
1972, 533 pages, (031657-0), \$17.50

Practical aspects of the subject are related to the theoretical in an attempt to give the student a working understanding of petrology and a basis for critical judgment. The author stresses concepts that can be used in field, handspecimen, and thin section work. Where appropriate, material is also drawn from chemistry, geophysics, and other fields. Technical terminology is kept to a minimum, and many photographs of rocks in the field are included.

## CHEMICAL EQUILIBRIA IN THE EARTH

Wallace S. Broecker, Columbia University, and Virginia M. Oversby, Australian National University / *International Series in the Earth and Planetary Sciences*  
1971, 318 pages, (007997-8), \$16.50

"This book is a tightly written, cohesive, but wide-ranging treatment of the application of the principles of chemical thermodynamics to basic problems in geochemistry and planetary sciences . . . (it) is a remarkably useful tool for equipping novices in the field with the language, logic, and essential mathematics of geochemical thermodynamics . . . Each chapter offers several problems intended to extend the scope of the discussion in the text, and even the casual reader may be tempted to pursue some of them. Familiarity with mathematics through ordinary differential equations is assumed." – John S. Lewis (Dept. of Earth and Planetary Sciences, Massachusetts Institute of Technology) in *Icarus* 16, 412-414 (1972).



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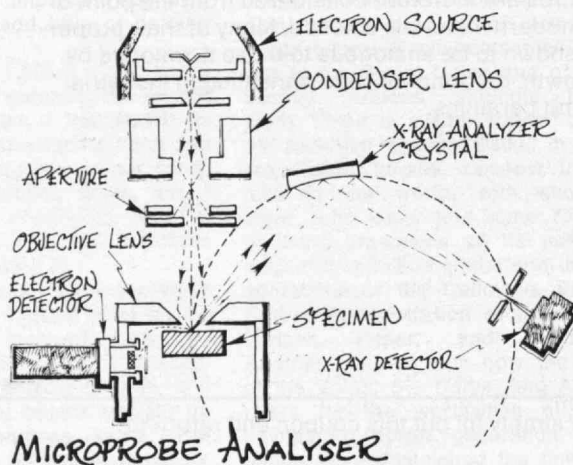
**M**aking it in Space . . . When the Apollo 14 astronauts headed for the Moon, they took with them three hermetically sealed capsules containing materials suggested by TRW. Inside were unlikely trios of ingredients: paraffin, tungsten pellets, and sodium acetate. Enroute, the astronauts heated the containers until the paraffin and sodium acetate melted, shook them to mix the ingredients, then set them aside to cool. On Earth, gravity would have separated the ingredients as they cooled, leaving tungsten at the bottom, sodium acetate in the middle, and paraffin on top. In space, however, gravitational forces were so small that the surface forces of the substances themselves predominated during the cooling process. The result: unique mixtures never before made by man were formed. The low gravitational field of space had allowed us to make a fully homogenized mixture of normally non-mixing ingredients. In the future this could mean a broad new class of materials with unique physical and electronic properties.

Such model mixtures are just one of the many possibilities space offers to pursue materials research and new manufacturing techniques. Recently, NASA's Marshall Space Center awarded us a contract to examine equipment for the extensive study of many future space materials. For example, the size of single crystals grown on Earth is limited by disturbing outside forces and contaminants. Not so in space. Thus, it may be possible to produce unique crystals for electronic applications or lenses of near perfect quality. Consider also a foamed steel which is not collapsed by gravity as it is cooled, so that it has the weight of balsa wood but many of the properties of solid steel. The space environment is also ideally suited for advanced processing of biological materials. Think, for example, of the subtle distinctions which could be made in a sustained low gravity environment between materials of very similar molecular weights. New vaccines, serums, and important immunological research might well result.

Right now, we are at work on an inventory of materials research opportunities and manufacturing techniques offered by the low gravity environment of space. If you would like to suggest some experiments, we would be happy to hear about them. We think the program is another illustration of the fact that space provides a unique opportunity to extend the current technologies of the planet Earth.

**... And on the Earth** Meanwhile, our terrestrial scientists at Space Park have been at work on some earth-bound materials problems of their own. We have a device called a Microprobe Analyser which irradiates a material specimen with a high-powered (but non-destructive) beam of electrons. The specimen thereupon gives off x-rays which are uniquely characteristic of the elements of which it is composed—i.e., a set of atomic fingerprints. In addition to performing detailed qualitative analyses, we can also do quantitative analyses by moving the beam across the specimen.

Using this new form of chemical reconnaissance, our materials sleuths have: (1) run quality control checks on the edges of a leading razor blade; (2) evaluated legal evidence as to whether or not a car's headlights were on at the time of a fatal highway accident; (3) found out why dental alloys in false teeth were not holding up well; (4) solved hundreds of problems that were beyond the scope of traditional methods. If you have a materials problem that's bugging you, drop us a line. Maybe we can be of help.



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Public interest in oil spill abatement may be traced directly to the grounding of the "Torrey Canyon" 16 miles off the southwest tip of England in 1967. The huge volume of crude oil released and the subsequent widespread contamination of British and French coastlines forcefully called attention to the effects of pollutant discharges and the difficulties in dealing with massive oil spills. Since then, enhancing water quality by reducing oil discharges has become a major goal of environmental protection activity.

But protection of water resources had in fact been a goal for many years before the "Torrey Canyon" incident. On June 29, 1888, the U.S. Congress acted to prohibit the discharge of any matter without authorization into New York Harbor, Long Island Sound, Chesapeake Bay, Baltimore Harbor, and the Harbor of Hampton Roads. The Refuse Act of 1899 restricted the deposit of any refuse, including petroleum products, in navigable waters, and prescribed fines and imprisonment for violators. These actions have more recently been extended by the Federal Water Pollution Control Act and its subsequent amendments. It was originally en-

acted in 1948 with the purpose of enhancing "the quality and value of our water resources and to establish a national policy for the prevention, control and abatement of water pollution."

Specific concern for preventing oil pollution is also not new. The recently repealed Oil Pollution Act of 1924 attempted to eliminate oil spills produced during routine vessel operations by fining operating personnel of any vessel who deliberately discharged oil or caused an oil spill through gross negligence. The 1954 International Convention for the Prevention of the Pollution of the Seas by Oil (implemented by the Oil Pollution Act of 1961) attempted to regulate the discharge of oil resulting from tank cleaning. In particular it prohibits tankers from discharging oily mixtures within 50 miles of land except under special circumstances, and it also sets criteria for allowable oil discharges for other types of ships.

Research on the oil spill problem began in the 1920s, and by 1960 these efforts had resulted in considerable information about the behavior and fate of spilled oil and several basic techniques for removing oil from a water surface and restoring oil-fouled beaches.

Most of this activity, whether regulatory or scientific, was directed toward the chronic, small-scale spill inherent in routine operations. Except for the tanker sinkings of World War II, there had been no demonstration of the effects of major spills or the problems associated with their clean-up. Though relatively large spills were not unknown, general attention had not yet been focused upon the massive oil spill.

It remained for the "Torrey Canyon" accident to dramatize the prob-

lems inherent in a massive spill. Efforts to control 119,000 tons of Kuwait crude only demonstrated the ineffectiveness of existing methods. The need for special organization and planning for control and clean-up became obvious.

The "Torrey Canyon" loss fostered a number of studies and investigations, among them a Report to the President prepared by the Secretaries of Interior and Transportation in February, 1968. Their recommendations defined three areas requiring attention—new equipment to prevent future oil losses, improved enforcement and regulatory procedures, and research and development of technology to manage pollutants if they are spilled.

## Toward Safer Harbors

Obviously, the best solution to the problem of accidental oil spills is to prevent their occurrence.

Since 1968, the Coast Guard, with guidance from local shipping interests, has established sea lanes in the approaches to major U.S. seaports. Regulations have now been developed to require deck spill containment systems, emergency shut-down valves in transfer systems, development and posting of approved instructions for conducting transfer operations, licensing of personnel in charge of transfer operations, and improved equipment tests and inspections. Other newly developed regulations would now require the exchange of basic information on ship movements between certain vessels and shore stations.

Each of these regulatory efforts should contribute to reducing the number of accidental discharges, either through improved operating procedures or avoidance of collisions.

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**William E. Lehr**, who holds the rank of Commander in the U.S. Coast Guard, is presently (since 1968) assigned as Chief of the Pollution Prevention Projects Branch in the Coast Guard Office of Research and Development, Washington, D.C. He studied at the Coast Guard Academy (B.S. 1953) and M.I.T. (Nav.E. 1961), has served in various capacities aboard Coast Guard cutters in Alaska, the Pacific, and the Atlantic, and was on Coast Guard combat duty off South Vietnam for one year, 1965-66. He holds the Vice Admiral Edward L. Cochrane Award (1961) of the Society of Naval Architects and Marine Engineers.

Events following the loss of the "Torrey Canyon" in 1967 showed how serious oil pollution could be and how little it could be controlled. Here is a review of progress since that staggering episode.

### Aids to Navigation

Measures to reduce shipping accidents by improved navigation systems have an important role in preventing pollution. Vessel traffic systems are one promising method, of which several examples can be listed: the stop-and-go traffic signals on the Mississippi River, control of traffic on the St. Marys River between Lakes Huron and Superior, a communications control network on the Chesapeake and Delaware Canal, radar-assisted navigation at the port of Long Beach, Calif., and a combined radar and communications system now in use in the Cape Cod Canal.

The most significant recent accomplishment in this field is an experimental vessel traffic system to help ships safely navigate San Francisco Harbor with the help of shoreside surveillance radars. A radar operator maintains information on the position, destination and intended task of participating vessels, and the operator also monitors the movements of all other craft in the harbor. He is in voice radio contact with the participating vessels to furnish advice on nearby ships and other navigational hazards.

This experimental system is designed to determine user acceptance of the shore radar monitoring concept, establish manpower and training requirements, demonstrate its economic feasibility, and identify needed technological improvements. Since its inception in January, 1970, it has been highly successful, and it is now being improved. New radars with automatic data processing and information display, including automatic true motion plotting, will reduce operator work loads, and improved communications procedures will ensure that pertinent informa-



This ultraviolet aerial photograph reveals more clearly than any conventional photograph the demarcation between oil (upper right) and water following a

Gulf of Mexico oil spill. The irregular line separating the clean and contaminated surfaces is about one mile long. (Photo: U.S. Coast Guard)

tion is transmitted in the most useful format.

Not every port should need a system as complex as that installed in San Francisco Bay. However, experience gained there with communications equipment and procedures, data processing, and radars should provide fundamental guidance for designing traffic systems in other ports.

#### **"Harmful Discharges" from Tankers**

The Federal Water Pollution Control Act prohibits the discharge of harmful quantities of oil into U.S. navigable waters and territorial seas. A "harmful discharge" has been defined by the Environmental Protection Agency as that quantity of oil which will create a sheen on the water surface; this "sheen" criterion means that an oily water discharge containing in excess of 10 p.p.m. of oil will create a harmful discharge. Outside U.S. jurisdiction the International Convention for the Prevention of Pollution of the Seas by Oil, 1954, as amended also limits the discharge of oily mixture.

Some discharge of oil is inherent in a number of routine ship operations. The potential for an oil slick exists each time bilges are pumped, ballasted fuel tanks are emptied, or cargo tanks are cleaned. In order to comply with federal and international requirements, special processing equipment, ballasting systems, and operating procedures are required.

The tanker industry has responded to these requirements by developing the "load on top" (L.O.T.) procedure for handling dirty ballast and slop water from tank washing operations. An empty tanker must fill some of its cargo tanks with water to maintain stability. The water mixes

with oil clinging to the sides of the tanks. This dirty water typically cannot be discharged at the tanker's destination, so practice has been to wash down empty tanks enroute and fill them with "clean" ballast. Traditionally, the dirty tank-wash-water has been discharged at sea. Tankers that practice the L.O.T. procedure, however, collect the dirty ballast and tank washing slops in a holding tank. Here oil and water separate by gravity; the water is pumped overboard and the separated oil is retained on board, to be mixed with the new oil cargo.

Not all tankers can practice L.O.T. procedures; either the type of cargo or short transit time precludes its use. However, some 75 per cent of the oil transported at sea is now carried in tankers equipped to carry out L.O.T., and its use has resulted in reductions in the amount of oil routinely discharged overboard by tankers.

Two other schemes to eliminate oil discharges from tankers are now being considered. One maintains clean ballast in segregated ballast tanks used for water only. These tanks are pumped dry when the tanker is loaded with cargo oil, and they are filled for the return unloaded voyage. The Maritime Administration, with Coast Guard and industry support, have investigated the impact of segregated ballast tank systems on first costs, operating economics and ship stability. Study results suggest segregated tanks are feasible for use in future ships, depending on their routes. For other ships backfitting costs for lost capacity would be prohibitive.

Another concept, the use of flexible membranes in cargo tanks to isolate water from oil, is currently under study by the Coast Guard. In this

scheme water for ballasting would be pumped into the cargo tanks on one side of the membrane. Oil would be pumped into the tanks on the other side of the membrane, forcing the clean water overboard.

All ships, whether or not equipped with L.O.T. or other ballast water systems, will require special equipment to process dirty bilge water, and the same type of systems may also prove useful for ballast water. To this end, development of efficient, high-capacity oil/water separators is a primary goal. Engineering feasibility studies of eight new separation concepts, jointly sponsored by the Maritime Administration, Navy and Coast Guard, are nearing completion. Concepts include ultrafiltration, electrofloatation, vacuum air desorption, vortex coalescence, differential viscosity, coalescing plates, and hydraulic vortex separation.

#### **Enforcing the Law**

Can we develop ways to better detect violations of the anti-pollution statutes?

For many years the Coast Guard has conducted routine surveillance overflights of harbors and the coastal high seas. However, detection from such flights depends on visual sighting and is thus limited to clear weather and to daylight operations. As a result oil slicks can go undetected, and they often wash ashore without warning.

In order to improve detection capability, the Coast Guard in 1968 began development of an all-weather, airborne sensor system to improve detection capability and subsequent prosecution of violators, to provide early warning of unreported spills, and to provide information on the location, quantity, and movement of a spill.

Four operational requirements for sensing equipment were established: it should provide reliable detection over a wide area; it should offer both real-time display and a permanent record of results; and it should indicate the quantity of oil involved.

#### Sensor Research

The first effort was to establish the electromagnetic response properties of oil films on water. Theoretical studies and laboratory and field tests were used to establish the dielectric constants and optical properties of a variety of types and thicknesses of oil from the ultraviolet to microwave parts of the spectrum, including such characteristics as the absorptivity, index of refraction, emissivity and fluorescence. The program also included preliminary assessment of the effects of environmental conditions—ambient temperatures, sea surface roughness and atmospheric conditions—on detection capability.

Later, a field test program using a series of controlled oil spills as well as actual spills of opportunity was conducted to validate the laboratory data and to establish the detection capabilities of typical remote sensors under real-world conditions.

Not surprisingly, it was found that oil films do have unique signatures upon which detection can be based. All of the sensor techniques listed above offered some capability for detecting oil slicks, but no single existing device would meet all desired operational requirements.

As a result of the earlier work, the Coast Guard is funding development of several specialized experimental sensor systems. When these are finally available they should furnish an all-weather, airborne surveillance capability.

The basic detection-mapping sys-



Recovering spilled oil is the third part of the Coast Guard's program to develop at sea clean-up capability. Straw is the

classic sorbent material—shown here in use in Santa Barbara, Calif. (Photo: U.S. Coast Guard)

tem will consist of a side-looking X-band radar for wide-area detection coverage; a scanning microwave radiometer and a multispectral scanner for narrow swath detection and detailed mapping; and a low-light-level television system capable of operating in both the ultraviolet and visible portions of the spectrum to assist in identifying violators. An experimental prototype is scheduled for completion in the fall of 1973, and successful completion of the test program thereafter should permit specification of equipment and procedures for routinely detecting anti-pollution violators on any navigable waters up to 50 miles offshore.

Two other sensing techniques are under study for possible integration into the airborne detecting/mapping

system. Laboratory experiments have demonstrated that oils may be grossly characterized as to type by their fluorescence, and so a nitrogen-laser-activated fluorescence sensor operating in the ultraviolet region is being investigated. Remote measurement of film thickness, necessary for quantifying the amount of oil spilled, is a severe problem. A multi-frequency microwave radiometer appears to offer a promising solution and is currently being investigated.

In the meantime, the Coast Guard is continuing its airborne visual surveillance program. As an interim measure, six patrol aircraft will soon be equipped with a sensor system based on ultraviolet and infrared scanners to provide a significant

#### **Projected Performance Goals of Control and Clean-up Equipment**

##### **Spill reduction (ADAPTS):**

Perform effectively in 40-m.p.h. winds and 12-ft. seas.

Be deliverable at a spill site by air within four hours.

Be capable of deployment and initial operation without assistance from surface craft.

Unload 20,000 tons of crude oil from a crippled vessel within a 20-hr. period.

Be self-contained, independent of support from the damaged ship.

##### **Containment barriers:**

Effectively contain oil in 20-m.p.h. winds and 5-ft. seas.

Survive 40-m.p.h. winds, 10-ft. seas, and two-knot currents.

Be suitable for air delivery on the site.

Provide an integral mooring system yet be towable by surface craft on the scene.

Be totally self-sufficient, requiring minimum support from on-scene forces.

##### **Harvesting equipment system:**

Recover 2,000 gal./min. of a range of oils from light crudes and distillates to residual fuels.

Perform effectively in 20-m.p.h. winds and 5-ft. seas.

Survive intact in 40-m.p.h. winds and 10-ft. seas.

Be self-sufficient regarding pumps, separators, and power sources.

Operate in conjunction with a containment barrier.

Be suitable for air transportation to the nearest port with subsequent ship delivery to the spill site.

Providing systems to meet these specifications for combatting the effects of off-shore oil spills has been the goal of Coast Guard research and development efforts since 1968. The ADAPTS spill reduction equipment has been successfully tested and some components

used in several pollution incidents; a floating containment barrier has been designed and shown to have the potential for meeting the specifications listed; and two prototype harvesting systems are planned for test in the summer of 1973.

improvement in antipollution surveillance capability.

#### **Finding the Guilty Spillers**

Each year a number of "mystery spills" appear along our coastlines and in various ports and waterways. Effective law enforcement requires identification of the source of these unreported spills, but a simple technique for tracing a spill to one particular source has not yet been found.

Most efforts to date have centered on laboratory techniques to analyze oil slick samples for comparison with samples from potential spill

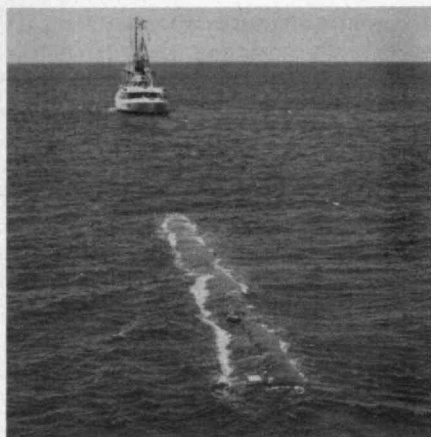
sources. The chemical composition of each crude oil is unique, and the Environmental Protection Agency and the oil industry have conducted extensive studies of various analytical techniques including gas chromatography, mass spectroscopy, and neutron activation analysis. Though these results have been applied with some success, there remain a number of practical problems. Spilled oil "ages," its composition being altered through biological decomposition, evaporation of more volatile components, and interchange of some components with water. Thus oil in an older slick can have a significantly

different signature from that of its parent. In addition, there may be more than one potential source for a slick of a particular kind of oil; for example, several vessels may have fueled from a single terminal, and any one of them, as well as the terminal, could be the source for a spill of the commonly held oil.

To eliminate these difficulties a number of additive "tag" concepts have been suggested, under which each carrier or potential source would add a small quantity of non-degrading identifying material to the oil it handles. Typical of the proposed additives are specialized organics and ferrites and nuclear isotopes. But there are difficult operational problems with additive tags. Ensuring proper addition of tags by each source could be difficult, and since oil transportation is a worldwide activity, international coordination would be required. Though the difficulties inherent in source identification are not insurmountable, considerable oil behavior research and development of operational procedures is still required.

#### **Planning for Disaster**

Despite our best intentions, oil spills will continue to occur through human error, environmental stress, or mechanical breakdown. Accidental spills reported to the Coast Guard totaled 3,711 incidents in 1970 and 8,736 incidents in 1971. (There is no reason to believe there was a significant increase in accidental discharges between 1970 and 1971. The 1970 amendments to the Federal Water Pollution Control Act, when passed in April, 1970, established mandatory spill reporting, and the Coast Guard was designated to receive the reports. Thus spill statistics for 1970 do not comprise a full year's



A prototype experimental container system which can be deployed at sea to receive oil pumped from a damaged ship was successfully tested in March, 1972, for strength and maneuverability. It is 173 ft. long by 12 ft. dia., with a capacity of 500 tons of oil. (Photo: U.S. Coast Guard)

reports, as do the 1971 data.) The spills ranged from a few discharges in excess of 1,000,000 gallons down to numerous spills of 1,000 gallons or less. Though the prevention activity previously described may effect a substantial reduction in the number of accidental discharges in the future, our best prevention efforts will not completely eliminate them. We must continue to expect spills, and we must develop greater capability to respond.

One of the first responses in the U.S. to the "Torrey Canyon" disaster was the formation of the National Interagency Committee for Oil and Hazardous Materials, including representatives of the various executive departments, the Office of Emergency Preparedness, and the Environmental Protection Agency. This Committee's efforts since 1968 have resulted in development of the National Contingency Plan to coordinate

federal response to a major spill.

This Plan, identifying the responsibilities of various member agencies and providing for coordination of their efforts, includes a National Response Center at U.S. Coast Guard Headquarters and a National Response Team, made up of member agencies, for planning and coordination. It specifies that all federal efforts at any spill site be directed by a single On-Scene-Coordinator (O.S.C.), with the Environmental Protection Agency typically providing the O.S.C. on inland waters and their tributaries and the Coast Guard having responsibilities for responding to spills in the coastal area, including harbors, the adjacent high seas, and other waters on which ocean-going vessels operate.

The National Contingency Plan also furnished the model for regional contingency plans intended to deal with smaller, local spills. Industry has also formulated contingency plans in the form of in-house spill response procedures and clean-up cooperatives in a number of ports.

But contingency planning is only the first step toward an adequate response. Effective clean-up techniques and equipment and adequately trained personnel are of primary importance.

#### Technology for Clean-up

No matter where it is, the steps to be taken in response to any oil spill are similar. They include securing the source of leakage, containing and concentrating the oil that has been released, harvesting the spilled material, disposing of the recovered liquids, and restoring contaminated areas.

But the circumstances surrounding each spill are unique. The way in

To test the efficiency of its "fence-type" oil containment barrier, the U.S. Coast Guard dumped 37,000 gal. of biodegradable soybean oil into the Pacific off Point Conception, Calif., in March, 1972. Evaluating the results, Randolph R. Thaman, Research Geographer at the University of California (Santa Barbara) concluded in Hughes Aircraft's *Vectors* magazine that "the Coast Guard may now have at their disposal an oil containment device which, although not totally effective at all towing speeds and environmental conditions, will serve as a very effective means of containing surface accumulations of oil . . ." (Photo: R. R. Thaman from *Vectors*)

which these steps are accomplished will vary depending on such factors as the quantity and type of material involved, the rate of its release, the location of the spill in relation to support bases, areas requiring special protection, disposal sites, and environmental conditions such as wind velocity, water current and sea state. It is these factors that determine the performance required of control and clean-up equipment.

Since 1968 both industry and government have worked hard to provide needed new equipment. Within government the Environmental Protection Agency and the Coast Guard have coordinated their efforts, E.P.A. concentrating on techniques suitable for sheltered water and the Coast Guard on rough-water equipment.

Three mutually supportive systems will be required to effectively combat off-shore spills. These are:

- ☐ Systems to reduce the quantity of oil released in a tanker accident.
- ☐ An oil containment system effective on the high seas.
- ☐ Oil harvesting equipment which can be operated at sea.

Provision of these systems has been the goal of Coast Guard research and development work for the past four years. The performance goals for each of these systems are shown in the adjoining table.

#### Spill Reduction

Roughly one third of the "Torrey Canyon" cargo was released quickly upon her grounding; the remaining cargo leaked slowly or was pumped overboard during salvage attempts or was released when the ship sank many days later. Some thought had been given during salvage attempts to unloading the cargo remaining before it was lost, but such a proce-





The containment barrier being tested here is the most successful yet developed by the Coast Guard. The barrier itself is

strong enough to withstand rough sea conditions, though collection of oil cannot be accomplished with waves greater

than about five feet. (Photo: U.S. Coast Guard)

ture—which might have reduced the total quantity of oil released and thus decreased the scope of the subsequent clean-up effort—was made impossible by rough water and shoals.

This and other tankship experiences made highly desirable an emergency system to unload oil from undamaged cargo tanks in high-risk situations, and the development of such a system was the first task undertaken by the Coast Guard after the "Torrey Canyon" disaster. This work is now completed. It has resulted in the Air Delivered Anti-Pollution Transfer System (ADAPTS), consisting of pumping, temporary storage, and parachute delivery subsystems.

The pumping system consists of a two-stage centrifugal pump with a hydraulic vane motor powered by lightweight diesel engine driven hydraulic pump. The pumping system is capable of pumping 1,000 gal./min. of median-viscosity crude oil through 300 ft. of 6-in. transfer hose. To date this transfer system has been used successfully in several pollution incidents. A series of collapsible, fabric containers make up the storage subsystem. Prototype containers capable of temporarily storing 500 tons of liquid are 173 ft. long and 12 ft. in diameter but can be packaged for parachute delivery on scene.

#### Containment Systems

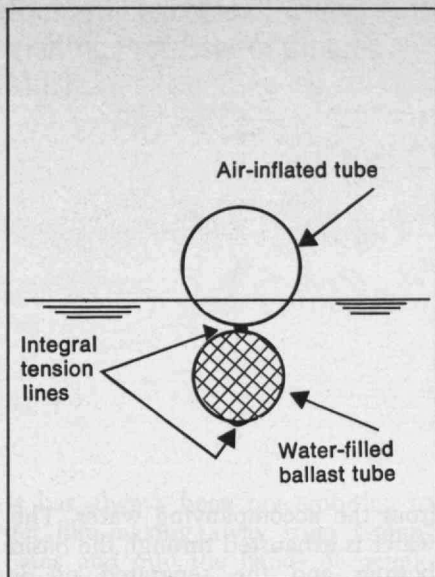
With the exception of a few crudes and residual fuels, oil spilled into the sea spreads rapidly to a thin film and is quickly transported away from a spill site by surface currents, winds and waves. Since all recovery techniques require a relatively thick film for acceptable efficiency, some containment device to control the spread of oil is required.

Most available containment devices are unsuited for use at sea. They are not strong enough to survive rough water or have inadequate wave conformance and upright stability. Although proper design can solve these problems, all floating oil barriers are subject to a much more critical performance limit. Oil that is restrained by a surface barrier is carried under the barrier if a current exceeding one knot is present in the water. Laboratory and field studies show that particles of oil are sheared off the leading edge of the contained slick by the current and "entrained" in the free water stream. With currents of less than one knot most of the particles reattach to the slick, but at higher currents leakage becomes catastrophic.

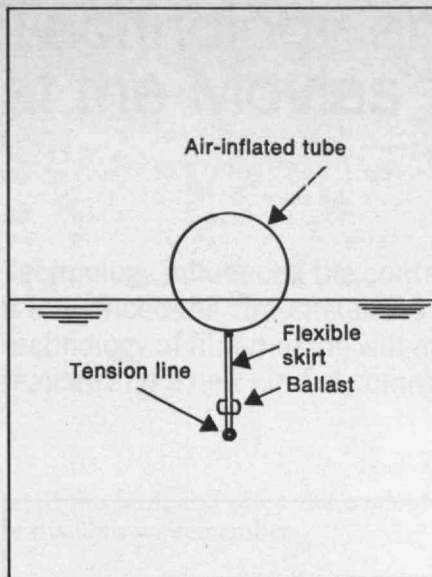
This "entrainment" phenomenon poses a severe problem. It means that oil cannot be contained by floating surface barriers in current fields over one knot or by sweeping vessels travelling at speeds of one knot

or more. Fortunately, normal wind-driven water currents at sea should be low enough to permit effective containment, but most ships cannot maintain fractional speed control, much less adequate steering, at one knot. Since the water velocity of most rivers exceeds one knot, spill control there will require special procedures if it can be accomplished at all.

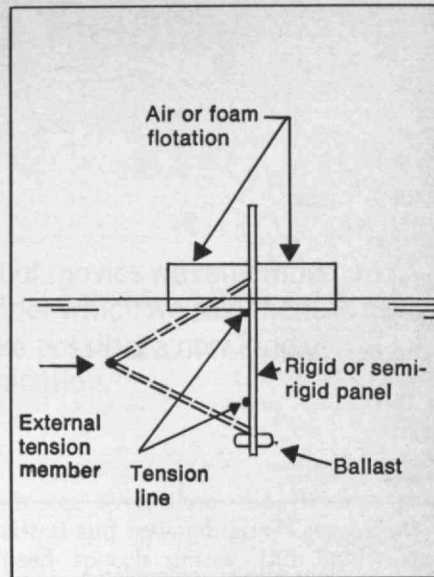
Despite these constraints the primary method for controlling spilled oil is the floating containment barrier. Efforts by the Coast Guard to develop an oil containment barrier suitable for use at sea began in 1968 and culminated in successful testing of an experimental prototype in March, 1972, following concentrated laboratory and theoretical analyses of motion response, strength, and the fluid mechanics of oil slicks. The prototype is a fence-type barrier of nylon-reinforced neoprene which extends both above and below the water surface, with a draft of 27 in. and a freeboard of 21 in. Buoyancy is furnished by air-inflated horizontal tubes 36 in. long by 14 in. dia., spaced every 66 in. along the barrier. Tests in March, 1972, demonstrated rough-water survivability and oil-retention ability as a function of current velocity and wave height. They indicate that the barrier has the potential to survive 40 m.p.h. winds and 10-knot currents



Floating barriers to contain oil slicks are of three general types—the multiple-tube barrier (left), the “float and skirt” system, and the “fence-type” barrier. The



U.S.C.G. fence barrier (see photo opposite) is built of nylon-reinforced neoprene with air-inflated tubes providing buoyancy. The barrier extends 21 in.



above the water surface and 27 in. below it.

and contain oil in 20 m.p.h. winds and five-foot seas.

Selection of five-foot seas (significant wave height) as a performance goal was initially based on operational considerations. Seamen have difficulty maintaining effectiveness when working from small service vessels in seas greater than five feet. Further, the size of equipment systems to perform in higher seas was expected to be too great to facilitate meeting air delivery requirements.

Subsequently several oil spills were reported to have broken up in seas greater than five feet, the oil being distributed in the water column. This phenomena is currently under study, and it appears to set a practical limit on sea conditions for cleanup purposes.

It is noteworthy that review of past records indicates that the five-foot sea criteria will allow clean-up of oil spills approximately 75 per cent of the time along U.S. coasts.

### Harvesting and Disposal Equipment

Once an oil slick is contained the pollutant in it must be recovered or disposed of. Many mechanical harvesting devices and chemical treatment techniques have been proposed for these purposes, several have been designed, and some have been tried at sea with real or simulated spills.

Chemical treatment techniques have not been favored, for they add materials to the ocean which may complicate the pollution problem or cause handling and logistics difficulties. Among the possibilities are chemical additives to foster burning oil on the water surface, use of sand or other materials treated to be hydrophobic and oleophilic so that it will agglomerate oil and sink it, and the use of emulsifiers to break up and disperse oil films.

Far greater emphasis has been given to developing mechanical recovery devices. Most of these can be grouped generally into five categories: skimming weirs, sorbent systems, inclined-plane devices, rotating-drum devices, and free vortex devices.

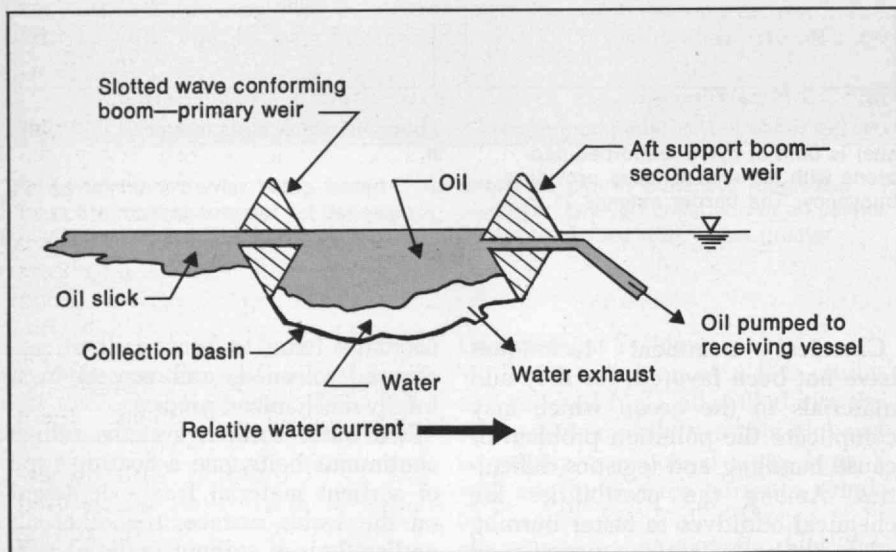
Many recovery devices place a weir near the water surface to remove the top layer of water and oil. Weir height may be adjusted in accordance with the thickness of the oil slick. Because their recovery efficiency is little affected by oil properties, weirs should in theory be effective harvesters. However, their performance at sea is often unsatisfactory because of wave action.

Sorbent materials have been used in several ways to develop recovery systems. Broadcasting and retrieving straw is the classic example. More recent proposals to improve sorbent action provide for the use of poly-

urethane foam to be broadcast, recovered, cleaned, and reused in a totally mechanized process.

Two other sorbent systems utilize continuous belts, one a floating rope of sorbent material freely deployed on the water surface, the other an endless belt of sorbent material permanently mounted in a special recovery vessel, the lower end piercing the air-oil-water interface. In both cases the belts are drawn through the oil slick to pick up oil, brought aboard a support vessel to be passed through squeeze rollers to remove recovered oil, and then returned to the water surface in a continuous operation. The effectiveness of such sorbent systems varies for different types of oils, since viscosity and surface tension directly influence sorbent performance, but these systems have the advantage of being relatively insensitive to sea-induced motions.

A downward-inclined plane terminating in an open-bottom tank has been tested for collecting oil slicks from water. The oil is forced down the plane as it is advanced through the water, and particles of oil are collected in an open-bottom tank behind the plane as they rise back to the water surface. The critical parameter here is the length of the open-bottom collection tank. It is influenced by oil properties and water current velocity. This concept



This wave-conforming weir for recovering oil from a water surface is approaching the stage of prototype test. Drawn through the water from right to left, the

weir collects oil and water off the surface in a basin from which the water escapes at the bottom and collected oil is pumped to a recovery vessel to the rear.

has been tested with some success in smooth water.

Oil will adhere to a metal drum or series of discs rotated through an oil slick, and the oil that is picked up can be scraped from the metal surfaces and collected aboard a support vehicle. Experience with drum units used successfully in calm water and in laboratory tests indicate that oil viscosity, speed of rotation, and drum size control the recovery rate.

A propeller rotated a short distance below the water surface will create a vortex flow. If this is done in water beneath an oil slick, the oil tends to collect in the depression in the center of the vortex flow, from which it theoretically can be removed by pump suction. There are problems: the vortex "pocket" may be unstable in waves, and propeller depth and speed must be critically adjusted to

prevent the collected oil from draining through the propeller. Successful tests of an experimental free vortex device at sea have been reported by the French government.

Coast Guard research and development projects to develop oil recovery equipment for use on high seas are well underway. Preliminary studies of all of the foregoing techniques have been completed and two experimental prototype oil recovery systems are being constructed. One is a rotating-disc drum, the other a wave-conforming weir. The latter is made up of two closely spaced booms connected at their bottoms by a fabric basin. As the weir is drawn through an oil slick oil passes through slots in the forward barrier and is collected in the space between the booms, where it is held for primary separation

from the accompanying water. The water is exhausted through the basin bottom and the separated oil is pumped through the second boom to temporary storage containers.

Both of these prototype harvesting devices will be ready for testing at sea early in the summer of 1973.

### The Uneven Struggle with Nature

Since the "Torrey Canyon" episode significant progress has been made in improving our capability to cope with oil spills. New regulations, vessel traffic systems, shipboard oil/water separation equipment, and sensor equipment for improved law enforcement should all foster reductions in the number of pollutant incidents. In addition, progress is being made in developing control and clean-up systems and procedures to handle accidental spills. Though this article emphasizes activities of the U.S. Coast Guard, readers should recognize that a considerable worldwide effort to control oil pollution and its effects is underway. In the United States the work of the Environmental Protection Agency, the Maritime Administration, and the U.S. Navy is particularly important; industry has also made major contributions, particularly in the area of control and clean-up equipment.

But much remains to be done. Systems now under development must be completed, and new prevention and law enforcement procedures must be implemented. Spill response systems effective in high currents still are lacking. And specialized equipment and procedures to cope with oil spills in cold climates remain to be studied. The forces which man can bring to bear often prove puny beside those of nature against which they are arrayed.

# Technology and Reality at the Movies

Technology influenced the content of movies we remember, and it influenced the circumstances under which we saw them. A new technology of film-making will make possible a new kind of realism and a new kind of communication.

It has always been my ambition to get film-making away from technicians and into the hands of people who have something to communicate. Ironically, it seems that this will never be accomplished without becoming involved in precisely the technology of film-making, because it is technology that makes film-making inaccessible to communicators as it becomes more complicated and more expensive. The latest super-films cost something like twenty million dollars—enterprises that have more to do with investment banking than communication.

I am assured that "film is *the* medium today," that "everyone is into film," and I am aware that there is a vast army of young people making films. Yet I'm equally aware that they are constantly frustrated and that their work is in effect suppressed by the nature of the system of producing and displaying films. There is no alternative to this system because we have not found solutions to some important social and technological problems.

But before examining the frustrations of today, it would be useful to look briefly at the development of the technology of film-making. For in my view, the problems extend into the past: technology has dic-

tated the form and often the content of the films we remember.

## The First Breakthrough

The films from the silent era that I still look at with great pleasure and that still seem almost modern fall roughly into four groups: those based on the ancient art of pantomime (Chaplin); those based on cinematic tricks (Keystone Cops); those that recorded real life (Flaherty); and those that used a stylized imagery of theatre or poetic form ("Caligari"). Then there are two groups that I find very odd to look at today: the "play films" in which a play without words was performed by actors reduced to making outlandishly broad gestures, while the medium tried to help elucidate the crude plot with titles; and the extraordinary development that took place in the Soviet Union where revolutionary themes had to be conveyed to audiences who could not read titles and, at least partly as a result, a form of gut sign language was developed. Combined as they were with revolutionary zeal, the Soviet films caught the fancy of those intellectuals who were just becoming aware of film as an art form.

I think most people would agree that the least interesting of all six groups was the "play film." Almost none have survived; the run of the mill Hollywood films—of which thousands were made, such as "The Eternal Triangle" with Mary Pickford—are amusing for about five minutes and agonizing after ten.

What happened with the advent of the first big technological change: sound?

There is almost no pantomime any longer, even though Chaplin, at that time a hero with a far greater following than Jesus and probably

greater even than the Beatles, resisted and resisted. His "City Lights" used speech noises, but finally he gave in and in a sense gave up.

The old cinematic tricks no longer worked. In a modern chase sequence, for example, the chase must be "realistic," largely because sound and dialogue impose real time upon film. In the wonderful, zany chases of the Mack Sennet period, action could be speeded up, wholly improbable cuts were possible—it was a cinematic fantasy. With rare and rather special exceptions, these cinematic fantasies died out.

The Soviet tradition, with the exception of a few films which used the image much as before, adding sound in an operatic rather than a realistic manner, completely disappeared. There was no further need for a sign language. Pudovkin's second sound film, "Suvurov," was nothing but talk accompanied by static images—an astounding transformation.

After a few years, the trend became very clear. The "play film," so unmemorable, though so numerous, when silent, had annihilated three species of film development, leaving itself and the recording of real life, the "Documentary," to react in their particular ways to sound.

The play film, using synchronous sound dialogue—with an overlay of music to give dramatic values to wooden acting—began to inch slowly toward the kind of "realism" that we accept today.

## The Documentary in the Sound Era

A philosophy for the documentary had been well expressed in 1904 by Leo Tolstoy:

"It is necessary that the cinema should represent Russian reality in its most varied manifestations. For

**Richard Leacock** made his first film, "Canary Bananas," at the age of 14; he had been raised on a banana plantation in the Canary Islands. The film, and the coincidence that he attended school in England with Robert Flaherty's daughters, led Leacock to a job: he was hired by Flaherty to work on "Louisiana Story," Flaherty's last film. Professor Leacock has made more than 200 films, but he "cannot remember the titles of many of them." One, "Monterey Pop," became a commercially-distributed hit. He has been at M.I.T. since 1969, developing academic programs in film-making and film-making equipment.

this purpose Russian life ought to be reproduced as it is by the cinema; it is not necessary to go running after invented subjects."

However, this was an illusion for the time being. Without dialogue it was possible to communicate only actions and settings, with the natural result that people tended to make films on processes—the way Nanook builds his igloo, the way he catches a seal, or subsequent British documentaries on catching fish or blowing glass.

The new sound equipment meant little to documentary makers. It was hopelessly bulky and at first could be used only in studios. The result was a form of documentary that used silent footage and added a voice-over commentary. Music filled up the gaps. In the last gasp of an epoch, the form depended on stirring music, pseudo-poetic sound narration, and rich imagery that could often be made to serve just about any propagandistic purpose.

By 1936 sync sound equipment had developed to the point where film crews could "go on location"—a euphemism meaning that the location became a surrogate studio. The avant garde of the documentarians set out to mirror the real world in sound and pictures, a well intentioned aim that almost succeeded in killing documentary film-making and gave the word documentary a connotation from which it has never recovered.

A situation in real life deemed to be socially important was first "scripted." Then a veritable army of technicians with truckloads of equipment descended upon the hapless "real" subjects in their "real" habitat. Thousands of feet of electric cable were laid, acoustic blankets were hung to reduce the echo,

windows were covered with gelatin filters to reduce the intensity of outside light in relation to the interior artificial lights that were erected. A mammoth camera weighing some 200 pounds was mounted on an immense wheeled stand known as a velocitator, which made camera movements possible. A microphone boom was installed. The director would go over the "action" and the dialogue and then on into the full studio routine of "Lights! sound! camera! action!" with the added admonition from the director to the subjects to "relax and just be yourself."

It was not long before directors who wanted to achieve a "natural" effect realized that this could better be done by employing professional actors to replace the "real" people. In short, starting with the best intentions, film-makers destroyed what they had set out to capture, then recreated a grade-B studio version that had no more validity than any other theatrical films.

### Filming Reality

If we were ever to achieve any part of Tolstoy's dream we had to reduce the impact of the filming process on our subjects. Not only the documentary film-makers saw this need; actors in theatrical productions in play films are trained to be impervious to their surroundings, but of course they are not.

In 1959, Jean Renoir described the problem of motion picture technology in an interview with film critic Andre Bazin and Roberto Rossellini: "... In the cinema at present the camera has become a sort of god. You have a camera, fixed on its tripod or crane, which is just like a heathen altar; about it are the high priests—the director, cameraman,

assistants—who bring victims before the camera, like burnt offerings, and cast them into the flames. And the camera is there, immobile—or almost so—and when it does move it follows patterns ordained by the high priests, not by the victims.

"Now, I am trying to extend my old ideas, and to establish that the camera finally has only one right—that of recording what happens. That's all. I don't want the movements of the actors to be determined by the camera, but the movements of the camera to be determined by the actor. This means working rather like a newsreel cameraman. When a newsreel cameraman films a race, for instance, he doesn't ask the runners to start from the exact spot that suits him. He has to manage things so that he can film the race wherever it happens. Or take an accident, a fire. It is the cameraman's duty to make it possible for us to see a spectacle, rather than the duty of the spectacle to take place for the benefit of the camera. . . .

"The real creative artist in the cinema is one who can get the most out of everything he sees—even if he sometimes does this by accident. . . . The creator of a film isn't at all an organiser; he isn't like a man who decides, for instance, how a funeral should be conducted. He is rather the man who finds himself watching a funeral he never expected to see, and sees the corpse, instead of lying in its coffin, getting up to dance, sees the relations, instead of weeping, running about all over the place. It's for him, and his colleagues, to capture this . . ."

### Cinema Verite

It was after chasing Leonard Bernstein on a conducting tour of Israel with the ridiculous equipment avail-

The development of synchronized but unconnected recorders of sound and motion produced a movement called Cinema Verite, Direct Cinema—anything but the tainted word “Documentary.”

able at the time that I became directly involved in the search for a technological breakthrough. Had the motion picture industry or TV been remotely interested it might have happened more easily. However, they were not and are not interested.

The problem as we saw it was to reduce the film-making unit to two people, one person with a silent, manageable camera which could be held with no supports, braces, or other prosthetic devices on one's shoulder, the other person with a small tape recorder and microphone. Motion and sound were to be fully synchronous with no wire connecting the two devices that recorded them.

In the Fifties, the development of magnetic tape recording, the invention of the transistor, and the development of miniature, low-power circuitry that resulted, soon made possible this second technological leap that would produce a radical change in documentary filming.

By 1960 we had a working unit and the revolution was on. The movement that started then has been called Cinema Verite, Direct Cinema—anything but that tainted word “Documentary.” Whatever it is called, the emphasis is upon realizing Tolstoy's dream, making it possible to go out and observe life with radically less interference with the situation being recorded.

It was not long before play film makers started to use the same techniques, in which the camera is able to respond to a form of acting, much of it improvised, just as it would to a real situation. But perhaps a more important effect that this technique of filming has had on the play film is to expose the “reality” that was so much in vogue in the '50s and '60s as a shallow hoax.

For the final effect of film as a distortion of reality was a profound one: whereas 60 years ago most of what people knew was from their direct experiences, as the media developed, more and more of what we experienced was at second hand, highly prejudiced, and largely myth.

For example, I think that I know pretty well what goes on in courts of law, but when I question this belief I have to admit that I have never in fact been in a courtroom during a trial. My experience is based purely on films, television shows, and detective stories, which, I suspect, may well have been directed and even written by people with no better credentials than my own. Further, I had thought I had a fairly clear idea of what would happen if war were declared, but the period following the attack on Pearl Harbor was utterly different from my movie-myth; as far as I could observe, just about nothing happened around me. I have seen film versions of the Nazi takeover in Germany but I knew the films were wildly inaccurate because in this case I had my own experience: I lived in Germany for several months in 1936 and '37. The shift was far more subtle and therefore far more difficult to oppose.

We may now be seeing play films moving more and more away from ersatz-reality toward a more stylized and truly theatrical form, with much less of the “this-is-the-way-it-really-is” approach. Play films may be moving toward a poetic style attempted by a very few films in the silent era.

#### Today's Solutions. . .

We are now going through the painful process of manufacturing the first models of a complete Super-8 film-making system that is both sophisticated and cheap. This system was

designed for student use but clearly will have far wider application. It is possible, by editing film footage and transferring the edited version to color video tape, to make a 20-minute film in color with sound sync for an out-of-pocket cost of about \$180. If such a film could then be distributed on cheap video discs to be played on your home TV, then surely the basis for change exists.

Wherever possible, our system is based on existent mass-produced items, modified to do things they were not intended to do. The camera is a standard Super-8 camera encased in an aluminum box to suppress camera noise. Its motor is controlled by a quartz-crystal oscillator so that it transports film at precisely 24 frames per second. A separate cassette tape recorder, completely independent from the camera, is modified so that a 48 hz. crystal-generated control frequency is recorded on the tape with the sound track. Later, the sound is transferred to Super-8 sprocketed magnetic sound film by a “black box” that uses a photocell to count passing sprocket holes and compares that rate with the control frequency on the cassette. Thus the sound, now on sprocketed magnetic film, can be exactly matched to the images recorded by the Super-8 camera.

We designed almost from scratch an editing table similar to the new horizontal tables recently developed in Europe. It plays the Super-8 format visual and sound films simultaneously.

The edited sound tape is finally loaded on a transfer machine, and the picture on a modified mass-produced projector. The two machines are held in sync by the same “black box” used in sound transfer. There are many alternate final forms to



The word for these stills from the author's "Happy Mother's Day" is "grainy." Hollywood's stills are posed; these are enlarged frames from Richard Leacock's film about a town's celebration of the birth of quintuplets. Above, the American Legion Band, and at right, the parents "acknowledging the applause from an open touring car." With 24

frames per second presented to the human visual system, movies can produce more than the illusion of motion. Since useful visual information is randomly blighted by graininess in each frame, human vision's integration process also yields sharper perceived images than are actually present on any one frame.

choose among. The sound can be transferred onto the Super-8 film that recorded the image, the film can be blown up to 16mm, or the film can be projected into a tele-cine chain that produces videotape, such as a  $\frac{3}{4}$ -inch video cassette, or ultimately video discs for mass distribution.

#### ... and Today's Frustrations

So the technological problems are being solved. But it is not yet much easier to make films, and it is certainly no easier to get them shown.

Today, sophisticated equipment—both 16mm and Super-8mm—could be manufactured cheaply and easily. But it is not being done.

There are people who manage through sheer cussedness to get the expensive equipment and make films for an audience small in comparison to the audience for which television fare is deliberately designed. However, with very, very rare exceptions these films fail to reach their audience and cannot pay for themselves.

The problem is that an LP record that sells 100,000 copies is a success. A book that sells 100,000 copies is a success. But a film that is seen by only 100,000 is a disaster, and a television show that is seen by only 9,000,000 is also a disaster. Besides production cost, the main difference between books and records on the one hand and theatrical film and television on the other is that the former has a selective audience. There may be only five people in Aberdeen, South Dakota that want to read a book or listen to a record; they can. But imagine putting a film in Aberdeen's only movie theatre for five people, or using prime time on the tube for that sized audience. Scandalous!

Let us speculate on what might

happen if sophisticated equipment—either Super-8 film or video tape equipment—could be manufactured for a tenth the price of current “professional” equipment (and it can be) and that this equipment will make products (works of art?) in a convenient form (such as some sort of cassette; they already exist in various forms) that would cost a tenth of what normal films cost, and that these products would be available at your local supermarket for rental or purchase, and you could take them home and run them on your television set at your convenience, with friends or alone, without having to hire a baby sitter, find a parking place, stand in line, or go through any other aspects of the ritual of “going to the movies.” Then surely we will have a different fare available to us.

### The Relevance of Quintuplets

One of the most difficult questions is always, What should one make a film about? The normal approach of institutions such as television networks and the foundations is that films should be about subjects of general social importance. This approach sounds reasonable, and I accepted it for years. The problem is that it is largely meaningless; “Old Age in America” and “Pollution is Just About Everywhere” are among the current virtuous subjects, but such broadly nebulous themes almost never yield good films. These themes tend to push people in what I have come to regard as a dreadful direction.

Some of the very best films that I have ever been involved in making have been on trivial and even absurd subjects. Some years ago, James Lipscombe, who worked with us on a series of experimental films for



Time Inc., kept insisting that we should make an hour-long film, at a cost of something like \$80,000, about a football game that takes place between two high schools every Thanksgiving Day. Now I don't think any responsible executive of a serious enterprise would go along with such a project, but Bob Drew, our producer at the time, understood. The film was made. Several two-man crews observed what was going on in both schools for days before the game. At game time we had as many as eight crews, two assigned to film nothing but the coaches, others covering players driving to the game, in the locker rooms, on the sidelines. Entitled “Mooney vs. Fowle,” the film is to my mind a most extraordinary social document.

I was once asked by the *Saturday*

*Evening Post* to make a film about a woman who had just given birth to quintuplets in South Dakota. They wanted the film in order to exploit the situation—that is, for what I regard as the wrong reasons. Joyce Chopra and I made the film, also for the wrong reasons—we were broke. The events we filmed culminated in a spectacular celebration of the one-month birthday of the quintuplets, including a speech by the mayor wherein he says, among other things, that “never before in the history of the United States has a city official borne the responsibility that I bear today.” This is followed by a soprano singing “Moment Musicale” to the stunned amazement of our honored parents, and a parade, complete with the American Legion Band, drum majorettes and the mother and father of the quints, acknowledging

the applause from an open touring car.

My point in telling all this is that when I went to work on the film I thought it was a stupid idea. It was only in the making of it that we discovered we had a fascinating film. The *Saturday Evening Post* rejected it.

Do you think for a moment that the head of a TV network would have sent a film crew on a five-year voyage with a young biologist (no Ph.D.) on the Beagle? Has anyone seen films made by blacks on how a black child learns that white people have no use for him? Are the people of the so-called underdeveloped countries in Africa, Asia, and South America making their own entertainment films, educational films, observational films? Why not?

If it doesn't begin to happen with a breakthrough in technology that makes all this at least feasible, then we will know to look somewhere else for the bottleneck, because this dream of a simple form of communication constantly recurs. Let us go back to 1920 and Dziga Vertov in the first years of the Soviets. Here are his slogans:

1. Filmdrama is the opium of the masses.

2. Down with the immortal kings and queens of the screen! Long live the ordinary people filmed in everyday life and at work.

3. Down with the bourgeois imagination and its fairytales! Long live open everyday life!

4. Filmdrama and religion are deadly weapons in the hands of the capitalists. Only through showing our revolutionary daily life do we strike the weapon from the enemy's hand.

5. The modern art-drama is a relic of the old world. It is an attempt to

press our revolutionary reality into reactionary forms.

6. Down with scenarios of everyday life. Film it directly and as it is.

7. The scenario is a distortion of our life which the writer imagines; but we live our lives and are not dependent on fiction.

8. Everyone works and does not disturb others while they work. It is the task of the film-maker to film the people in a way which does not distract them from their work.

9. Long live "Kino-eye" and the proletarian revolution!

But when I look at Vertov's work—aside from his newsreels of famine, extraordinarily honest, but they could show no more than the physical horror of what was happening—I do not find the films he is describing above (a splendid program and exactly what I have been advocating if one removes the revolutionary rhetoric and clichés). Some think that Vertov was prevented from making such films. I think that it was simply impossible because the technology of the time did not permit it and this caused him to retreat into contrived and tricky films such as "The Man with a Movie Camera," which got him in trouble for being "formalistic"—and no doubt "right deviationist," "revisionist," etc., etc.

I do not wish to imply that all that we are going to get from the new technology will be a multitude of reflections of peoples' realities. The coming breakthrough is going to result in an avalanche of films, hopefully all manner of mixed media, inventions, poems, new species of opera. Making a bad film is much less work than writing a bad book and less difficult than making up even a lousy song. But we, the audience (the consumers?), will be

able to decide what goes and what doesn't go. I, eternal optimist that I am, think that given any opportunity, we really do seek to communicate with each other. And something *can* be done.

# The Technological Progress Function

In tracing the history of a technology, or predicting its future, time proves to be a less fundamental variable than experience.

Technological forecasts have traditionally viewed improvements in technology as simply a function of time. In the context of forecasting, relatively little thought has been directed to the underlying (and presumably changing) causes of progress. The general acceptance of a picture in which technology somehow improves inexorably with the passage of time—like an investment at a fixed interest rate—weakens the value of technological forecasting as we know it today.

The study presented here demonstrates the use of a "technological progress function," which relates a measure of technological progress, not to time itself, but to cumulative production of the artifact associated with that technology. This appears to relate to the underlying system of causes of technological advance, and to offer greater precision than the traditional time-dependent forecasts.

The "technological progress function" evolved from three considerations which turned out to fit together into a single pattern: the so-called "industrial progress functions"; the functions that psychologists have formulated in their studies of learning; and the suggestion—taken from research on the innovation process—that the characteristics of market activity for a type

of technology are related to the rate of innovation in that technology.

Let us start with the first of these.

## Industrial Progress Functions

Often, some measure of economic merit of a product—such as the cost of making a device or the cost of keeping it in working order—is related by an "industrial progress function" to the total number of devices that have been manufactured. These functions are quite well known, and take the form

$$Y_i = ai^{-b}$$

where, for example,  $i$  is the cumulative total of devices manufactured, and  $Y_i$  is the cost of manufacturing the  $i$ th device.  $a$  and  $b$  are constants. Set  $i$  equal to 1, and we see immediately that  $a = Y_1$ ; that is,  $a$  is the cost of manufacturing the first device.

To understand  $b$ , we take the logarithm of both sides of the equation. We get:

$$\log Y_i = -b \log i + \log a.$$

If we plotted the logarithms of  $Y_i$  and  $i$ , we would have a straight line. Thus we see that  $-b$  is a rate of sorts—not a time-rate but a rate of progress with respect to the total number of devices that have been manufactured. It is the rate at which cost-efficiency is improving as the total of devices manufactured increases.

Although there are a variety of types of industrial progress relationships, they all have two things in common. They are all similar in mathematical form; and they are all of some use in making micro-economic decisions—for example, decisions on costs, pricing, manpower, maintenance, or material supply. Thus, though they are called by many names (maintenance progress functions, manufacturing progress

functions, direct labor learning curves, etc.), they might all be called "micro-economic progress functions" (M.E.P.F.'s). Using other, more specific terms tends to imply differences that are not really fundamental.

## Production Functions

It would seem that an M.E.P.F. would have something to do with technological progress, since a technological innovation might well affect cost-efficiency of a production process. Yet economists—those to whom we might first turn for an explanation of the impact of technological change on production processes—have given this matter little attention. However, it is useful to review such work as exists on the technological component of any kind of progress function. For economists this work is in the area of "production functions."

Production functions relate output ( $X$ ) during a single period of time to the inputs of labor ( $L$ ) and capital ( $K$ ), and commonly take the form  $X = AL^aK^b$ . Only recently has the subject of technical change (which might entail an alteration of the value of any of the three constants,  $A$ ,  $a$ , or  $b$ ) received any concentrated attention. All but a few of the papers in this area—two notable exceptions are papers by Kenneth Arrow and Leonard Rapping—treat technical change as either residual error left unaccounted for by a production function, or simply as a function of time. (Some use residuals and time.)

The paper by Arrow (one of this year's Nobel prize winners in economics) represents the first attempt by an economist to consider technical change as a function of an industry's cumulative experience. How-

**Alan R. Fusfeld**, who is currently working toward a doctorate in research management at the Sloan School, M.I.T., studied materials science and engineering physics at Johns Hopkins University, Baltimore, graduating in 1970. By that time he had already begun to publish in the field of technological forecasting and had completed his first year at the Sloan School, where he is now also an instructor in managerial psychology. Outside consultancy work has included, notably, the setting-up of a financial forecasting model for a transport engineering company.

ever, Arrow does not measure this "experience" by reference to the industry which produces the products. He measures it within another industry which uses them: his measure is cumulative expenditure on plant and equipment. Nevertheless, his (purely theoretical) contribution suggests to economists that a rational relationship may be found between productivity improvement and experience, and may explain the shifts in production functions that heretofore have not been well understood.

The paper by Rapping is the only study I have found in the economics literature that to any extent tests Arrow's suggestions. Using the production data for fifteen different emergency Liberty-shipbuilding yards (1941-1944), Rapping shows conclusively that the experience—as measured by cumulative production—of each shipyard was the only variable that was of any use in making sense of shifts in the yard's production functions; time alone did not provide as good a correlation. Still, Rapping's focus remains on production functions; he does not attack the more general problem of technological change, and in fact he, too, regards technological change, when he mentions it, as a function of time.

**Decision-Making with M.E.P.F.'s**  
The applicability of M.E.P.F.'s to decisions in a business is not as simple as might at first be supposed. Certain characteristics of these functions present problems of decision that have not been solved, and this happens just where the influence of technological innovation (its influence upon the thinking of the baffled company-economist, at any rate) is greatest. The problems

begin when one attempts to assign a cost to the first production unit of what is regarded as a new design, that is, assign a value to the constant  $a$  in the M.E.P.F. It seems that one must be quite arbitrary as to how to factor in a share of the expenses which have been incurred in developing the innovation.

A mechanism by which technological innovation itself would merge into a long-term industry trend, so that the costs of a "new product" could be seen in the context of all of the previous generations of similar products, might help to alleviate this difficulty. Indeed, the whole business of "generations" introduces into industrial planning a complication that may be needless and artificial, for—as I shall show—there is a smoothness in technological progress which very often transcends even those changes which we regard as radical technical innovations. Let us move on to the second and third of our three considerations.

### The Psychology of Learning

There is considerable dispute over the exact definition of what learning is or is not, but in the context of psychological research, "learning" refers to perceptible gains in the ability to perform a given task (solving puzzles, going through mazes, responding to prearranged stimuli). It has been noted in a variety of projects involving animals and people that the efficiency of performing a given task increases with the cumulative number of repetitions. None of the studies find that the frequency of the repetitions has any influence, just as long as they recur within a certain "retention interval." So the time that the learning takes is not in itself important. The studies found that learning processes can be

expressed thus:

$$E_n = KN^d$$

where  $N$  is the cumulative total of repetitions, and  $E_n$  is the efficiency in performing the task at its  $n$ th repetition.  $K$  and  $d$  are so-called "learning constants."

Note that the mathematics takes the same form as it did in the M.E.P.F.'s. Further, Frank Logan, in his book *Incentive*, reports that his subjects "... behave in such a way as to maximize reward while at the same time minimizing effort." This sounds very much like the guiding aim of modern man's economic endeavors, and sounds very much like a drive in industry for technological progress. It would appear reasonable that the same type of learning that psychologists have studied might be a metaphor for the accumulation of "experience" which Rapping measures in economic terms.

### The Process of Innovation

That technological innovation is stimulated by the growth of associated industrial production has been suggested by a number of authors. S. C. Gilfillan, for example, as early as 1935, wrote: "Use promotes improvement. The rate of progress (in the performance of a device) tends to vary with the absolute rate at which that device is being turned out in practice."

Other more recent studies amplify Gilfillan's ideas. Sumner Myers and Donald G. Marquis note that recognition of demand is the most frequent stimulating factor for successful innovations. James M. Utterback last year summarized eight separate studies each of which examined several hundred innovations, and found that a minimum of 67 per cent and an average of 74 per cent of all innovations included in

Something must happen during the passage of time to bring about progress. What does happen is the accumulation of experience, measured most easily by cumulative production.

each study were stimulated by market or production needs (as opposed to originating as technical possibilities for which uses were subsequently discovered). This is true for innovations originating both inside and outside the industry in which they are used (in spite of the fact that the latter was more usual, by a factor of three).

Jacob Schmookler used the number of patents as a measure of inventive activity in a particular industry and—consistent with the other research—found it to be directly related to the amount of business activity. He states: "... [There is] this tendency for the solution of technical problems to be stimulated or inhibited by the level of sales of the products involved . . . and an inventor—or the firm employing him—will tend to press for a solution when sales are high and slacken his efforts when sales are low." Market activity, then, stimulates technological innovation.

There are two connections between market and innovation. First, there is the learning that occurs directly from performing production processes. This is succinctly described by Schmookler:

"The identification of a problem can occur at any time during the use, or observation of the use, of an article or piece of equipment. And the man with an irrepressible urge to improve things may, without any special economic motivation, begin inventing as soon as he 'recognizes' the problem. The problem may be solved in minutes. In this case . . . there need be no association between the given act of invention and the level of investment. On the other hand, as often happens, the solution may take years. In the latter case, the internal drive is likely to slacken and the work be put aside and taken

up time and again. Under these circumstances, economic motives (or the desire for the recognition which economic success brings) are likely to become relatively more powerful as the first surge of enthusiasm wanes. Now, if sales of the product the inventor wishes to improve are high, he is likely to push harder to finish his improvement and make money from it, while if sales are low, his efforts may subside. Thus, there will tend to be some positive correlation between the sales of a product and the timing of difficult improvements, even when the initial stimulus to the inventor was non-economic."

The other connection is very well known: it is the *ad hoc* decision rule used by most businesses that support research and development: a given percentage of each year's sales is allocated for research and development, this percentage being relatively constant over time.

Thus, three specific technology-production linkages are suggested by current research on innovation: innovation is commonly related to market behavior; technological improvements can be stimulated by direct exposure to production processes; and expenditures on research and development efforts are generally related to current sales volumes.

### Measuring Technological Progress

We have said that technological forecasts have hitherto taken technological progress to be a measurable function of time. Specifically, these forecasts have taken progress to be roughly exponential with respect to time. They have taken the form

$$T(t) = Ke^{ct}$$

where  $T(t)$ —in words,  $T$  as a function of time—is some measure of

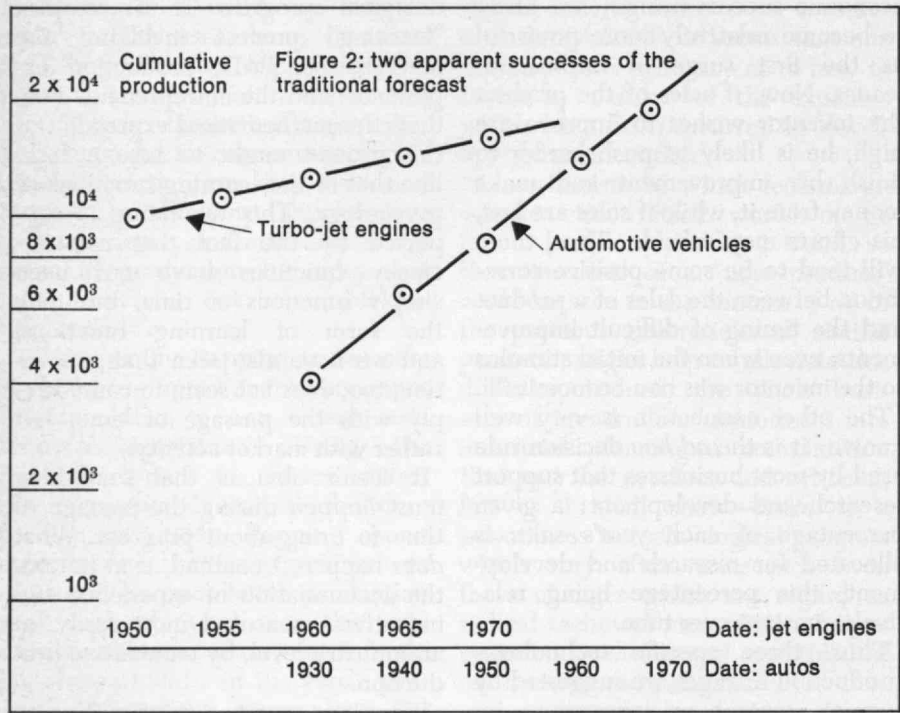
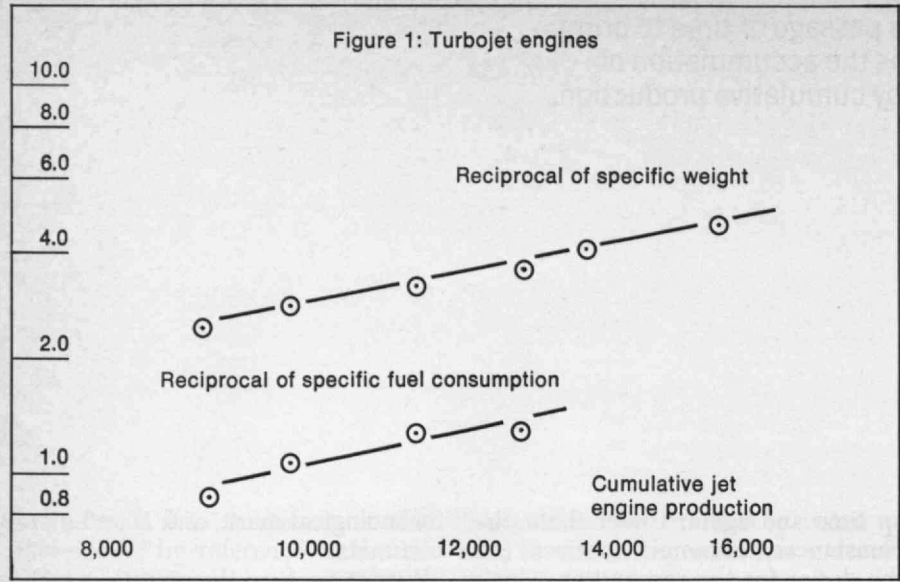
technological merit, and  $K$  and  $c$  are constants.

But let us now theorize that technological progress is a complex "learning" process involving the marketplace, R&D, production experience, and the entrepreneur. Further, the mathematical expression of this process ought to take a form like that of the learning functions of psychology. This theorizing is supported by the fact that cost-efficiency functions have not been simply functions of time, but took the form of learning functions, and we have also seen that innovation, too, does not seem to come simply with the passage of time, but rather with market activity.

It seems obvious that something must *happen* during the passage of time to bring about progress. What *does* happen, I contend, is at bottom the accumulation of experience and incentive—measured most easily, at an industry level, by cumulative production.

"Environmental factors"—economic and political—also ought to enter a description of technological progress. It seems reasonable to guess that these factors will determine the value of the "learning constant" that appeared in the M.E.P.F. as the constant exponential  $b$ , and in the psychological learning functions as  $d$ . This is strongly suggested by the literature associated with these two areas. Then, as we would expect, economics and politics would determine the rate at which progress will occur for a given input of experience.

Given this hypothesis, real data have been sought, to test it. The most difficult problem was that of obtaining accurate data, particularly with regard to costs and production. This difficulty was solved



The two graphs above are the first of a series of 13 accompanying this article. They are discussed sequentially and in detail in the text. Figure 1 shows two measures of technological progress for turbojet engines. Figure 2 plots two apparent successes of the traditional time-dependent forecast of progress. Figures 3 and 4 treat light bulbs. There appears to be a change in the rate of progress about 1920, the time of urban electrification. Also at this time, the rate of growth of light bulb production slowed. In figure 5, computers are shown to obey a technological progress function over size orders of magnitude and several generations of computers. The earliest phases of computer design do not deviate greatly from the line; but early progress is slower. Figure 6 is a technological progress function for automobiles; figure 7, a traditional forecast. While the latter shows

no great deviation from linearity, the former appears to break progress into two periods, with a change occurring about 1925. The automobile's rise as "practical" transportation rather than toy might have commenced then. Figures 8 through 11 treat aircraft, military and civil, by various forecasting techniques. In figure 8, two points deviate strongly from the progress function: one in 1931, during the Depression, and one in 1960, with the advent of the jet engine. Under constant "environmental" conditions, average speed of 600 m.p.h. would not be predicted until about 1980. But this 1960 deviation predicts a steeper line, producing the Concorde and the S.S.T. within 10-15 years. In figures 12 and 13, the technological progress function is applied to titanium, a matter of metallurgy and economics, and to agriculture—specifically, the efficiency of rice production in Japan.

by combining data from several sources, and where possible having the material validated by someone familiar with the particular field. Concerning the choice of technical parameters in these studies: in most cases—where the new studies were direct modifications of existing technological forecasting studies—the technical parameters considered were the same as had been used before (and thus had generally been used to arrive at conclusions quite different from my own).

**Turbojet Engines**—The data concerning turbojet engine development covers a period of nearly twenty years, during which time a number of "generations" of engines succeeded one another. The data available were first condensed into a set of points each representing one generation of engines.

Figure 1 shows two measurements of technological progress in turbojet engines: "specific weight," the weight of the engine divided by the pounds of thrust the engine can produce; and "specific fuel consumption," the pounds of fuel consumed in an hour divided by the pounds of thrust developed by the engine. When we plot the logarithms of these two measures of progress versus the logarithm of cumulative production, Figure 1 shows that we get two straight lines.

When we discussed M.E.P.F.'s at the beginning of this article, we found that when we took the logarithms of both sides of those equations, we got straight lines. Thus we find in turbojets evidence in favor of our hypothesis that technological progress takes the same mathematical form as M.E.P.F.'s and psychological learning functions.

But note (in Figure 2) that traditional technological forecasting also appears to work. The form of those traditional forecasts was

$$T = Ke^{ct}$$

Let us take the logarithms of both sides:

$$\ln T = ct + \ln K$$

We see that, according to this forecast, the logarithm of technological progress plotted against time, should produce a straight line. Remember that the traditional forecast saw progress simply as a function of time. Figure 2 appears to indicate that this is true.

But this, I suggest, is a fortuitous coincidence. Technological progress seems to be strongly correlated with

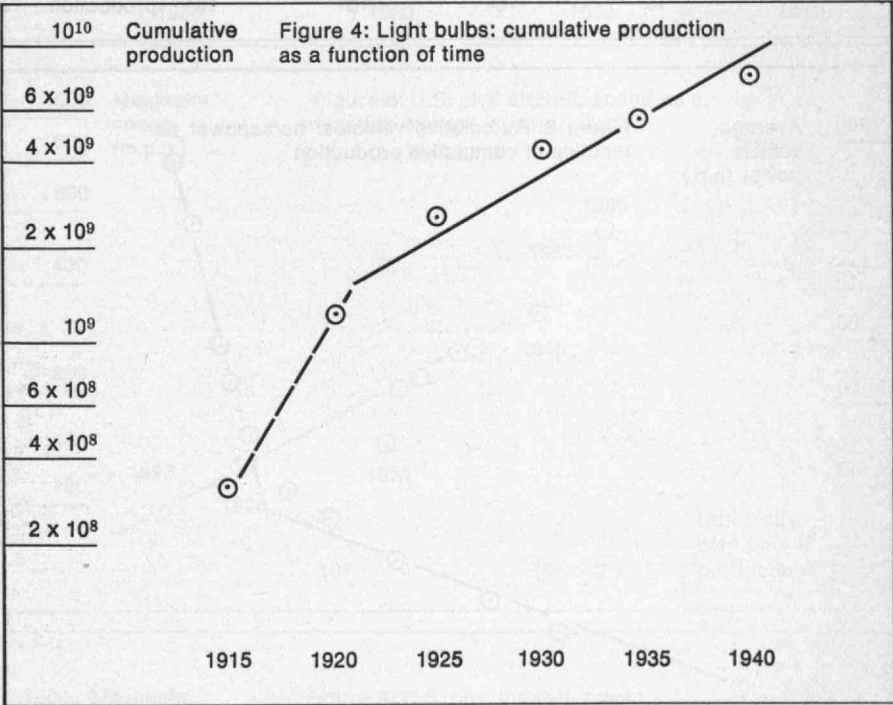
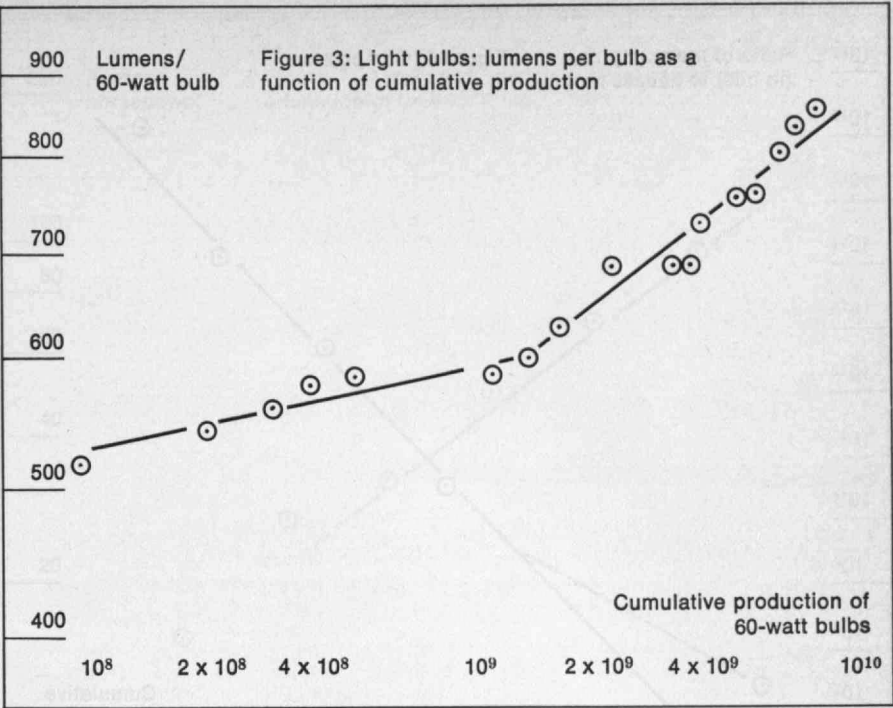
time when cumulative production not technological progress, undergoes (in the famous "exponential growth" phenomenon) a constant percentage increase with respect to time. I will show all this in greater detail later in the article.

Two additional points are noteworthy. The first is that the slopes, representing the learning constants, of both technological progress functions are virtually identical. This would lend support to the thesis that the same environmental factors present in two areas of product improvement will result in progress at the same rate, if the same measurement of production is used. The two areas of improvement considered in this example share nearly identical environments as regards numbers of technical personnel, amounts of research and development, investment, demand for the product, and political, economic, and social pressures.

The second point is that, given the technological progress function for specific weight as of 1965 (the actual limit of the study from which the data were taken), and noting that the environment for aircraft production remained essentially the same between 1965 and 1969 as it had been in earlier years, one can accurately predict specific weight for 1969: about 0.220. The actual figures averaged 0.216.

*Electric Lamps*—The electric lamp study was concerned with technological progress as represented by the output of the lamp in lumens per watt. The multitude of development changes made it unnecessary to examine the lamps by individual generations.

The results (Figure 3) confirm the existence of a technological progress function behaving in accordance with the form of an M.E.P.F. There appear to be two rates of progress, one from 1912 to 1920 and the other from 1920 to 1940. This would imply that the external environment affecting the lamp industry underwent a shift. Since the rate of growth of production, which had been a steady 9.4 per cent per year throughout the first period, fell to 2.7 per cent at about the same time (Figure 4), it may be concluded that the same change or changes in the environment gave rise to both effects. For example, it could be that when market expansion became more difficult due to the completion of urban elec-

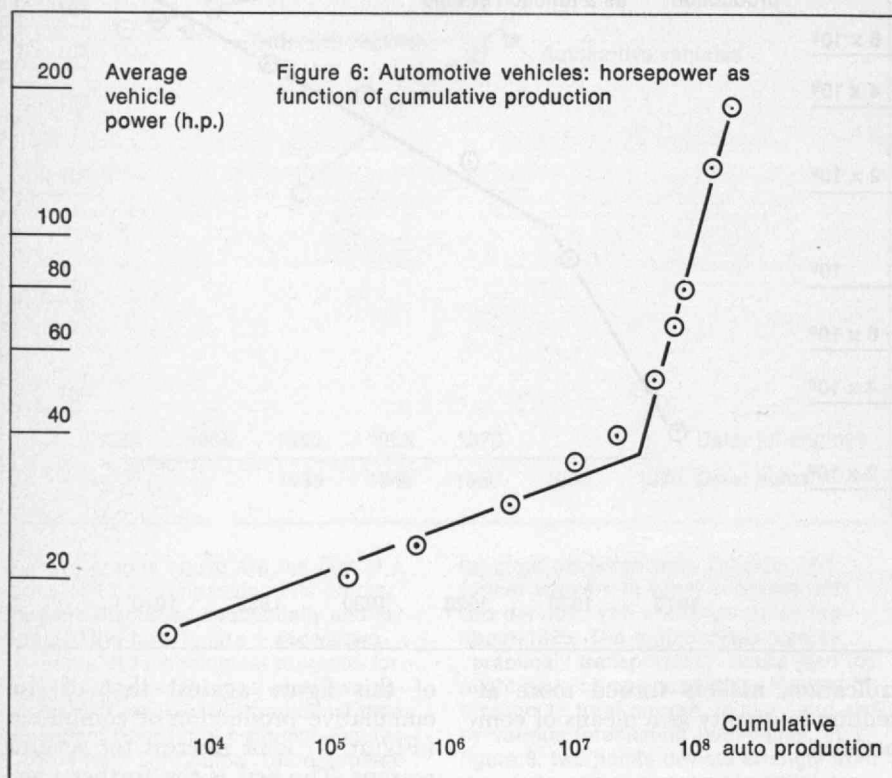
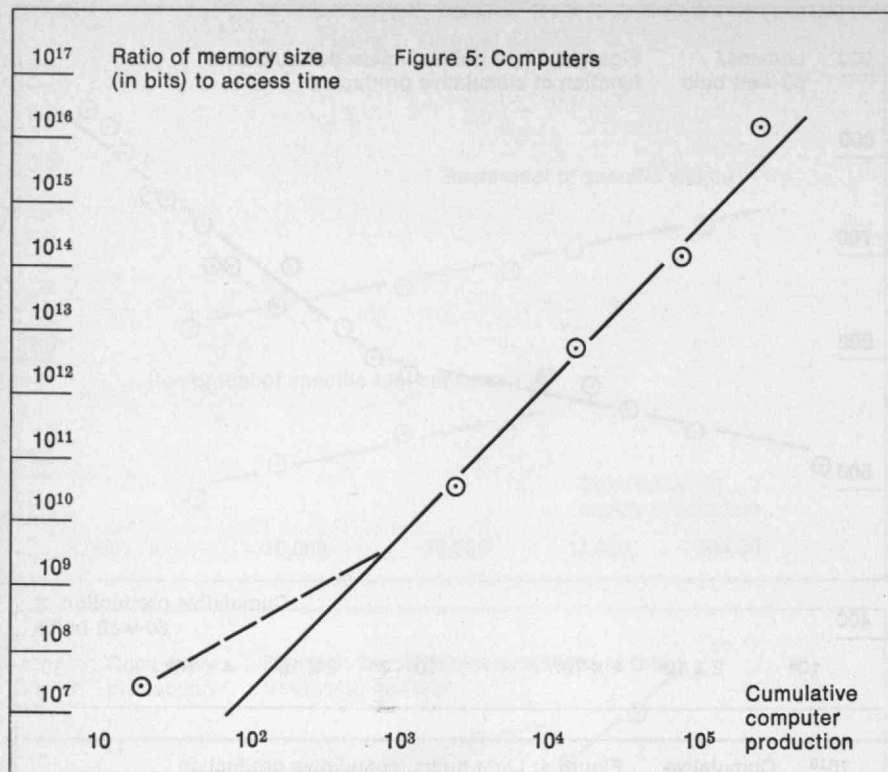


trification, makers turned more attention to quality as a means of competition.

*Computers*—The progress made in computers during the last twenty years was monitored using a figure of merit which combined two widely-used measures of computer "power," namely the size of the computer's memory, and the average time required to retrieve information from memory. The figure of merit used was the ratio of these two measures.

The result of plotting the logarithm

of this figure against that of the cumulative production of computers (Figure 5) is of interest for several reasons. The first is the further verification of the existence of a technological progress function. There is also the fact that a single trend extends across several orders of magnitude of cumulative production, six orders of magnitude of performance, and—in the official parlance—three generations of machines. Finally, this case is of interest because it shows evidence that, even at the earliest stages of an industry, technical "learning" may proceed at a



rate not very different from the rate which sets in later when the industry becomes established.

**Automobiles**—If technological progress is measured by the average horsepower of vehicles, we obtain a plot (Figure 6) which resembles that for the efficiency of light bulbs; that is, it shows an upward shift in slope which might be accounted for by a change in the market and pro-

duction environment. (The two measures are of different kinds technically, of course: for light bulbs, efficiency, while for automobiles, simply power. Some might question whether greater power in automobiles is really progress; but, like efficiency in lighting, it is what the majority of purchasers want, and its achievement in production cars has required the solution of technical problems.) The shift in slope—by a

factor of 6.7—occurs in the late 1920s, when a variety of interrelated changes in the environment might indeed have taken effect.

First, the automotive vehicle had at that time just moved into a phase of increased durability and desirability as a capital good, after a period during which the automobile was a toy for the rich, the horse was fair or better than fair competition for it as regards performance, and bicycle-riding policemen apprehended drivers for speeding. World War I changed the image of the automotive industry from both within and without, by giving strong indications of the possible utility of automotive vehicles.

Another major change in the automotive environment in the early 1920s was caused by the development of a new type of tire—a technical change, admittedly, but one that produced its major effects through its influence on the market environment, rather than through the industry's internal innovation process. The new tire replaced the bicycle type of tire used previously, and had two important advantages. It lasted much longer, thereby making the automobile less costly in maintenance and less liable to make trouble for its owner. Secondly, the tire could withstand higher speeds, adding to the automobile's advantage over other systems in terms of travel time.

Further, market demand for cars was stimulated by government investment in public roads. Beginning in the period 1924-1928 the government not only assumed a large share of road-building costs, but actively increased the rate of new highway construction.

Thus, a major shift in the environment coincided with the observed shift in our technological progress function. (Notice that the conventional time plot [Figure 7] does not reveal this connection, showing a shift—if anywhere—around 1910.) If the relation that we assume exists between environmental conditions and rate of technical progress (the exponent  $b$ ) could be made explicit, shifts in the technological progress function could be predicted with some precision because important environmental changes in their early stages can certainly be spotted by observant planners.

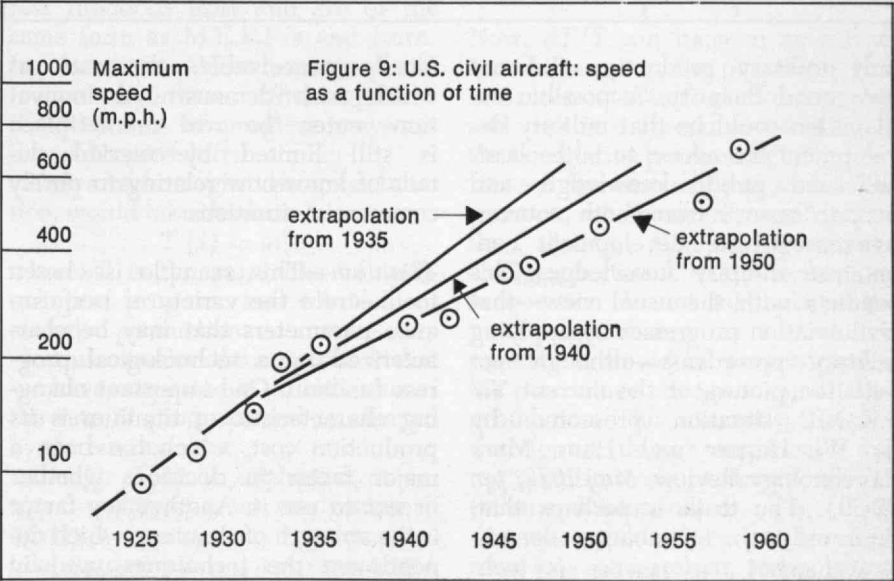
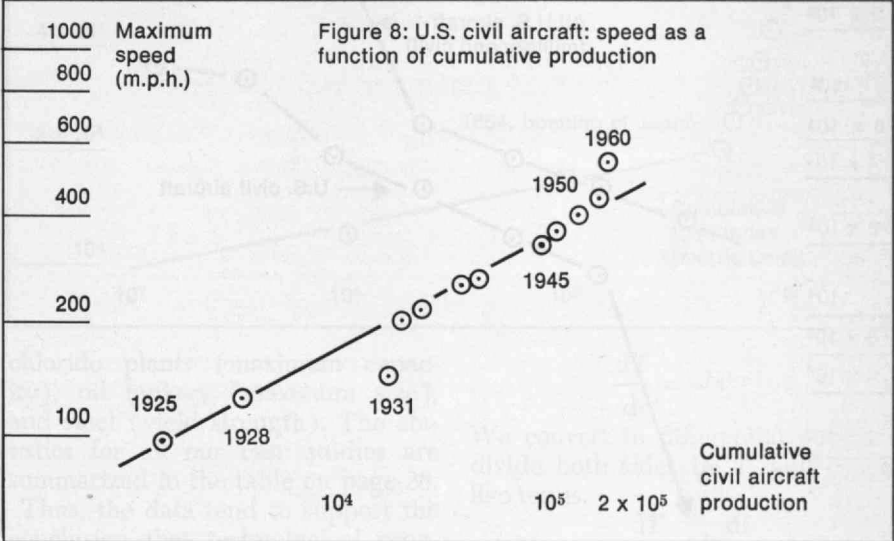
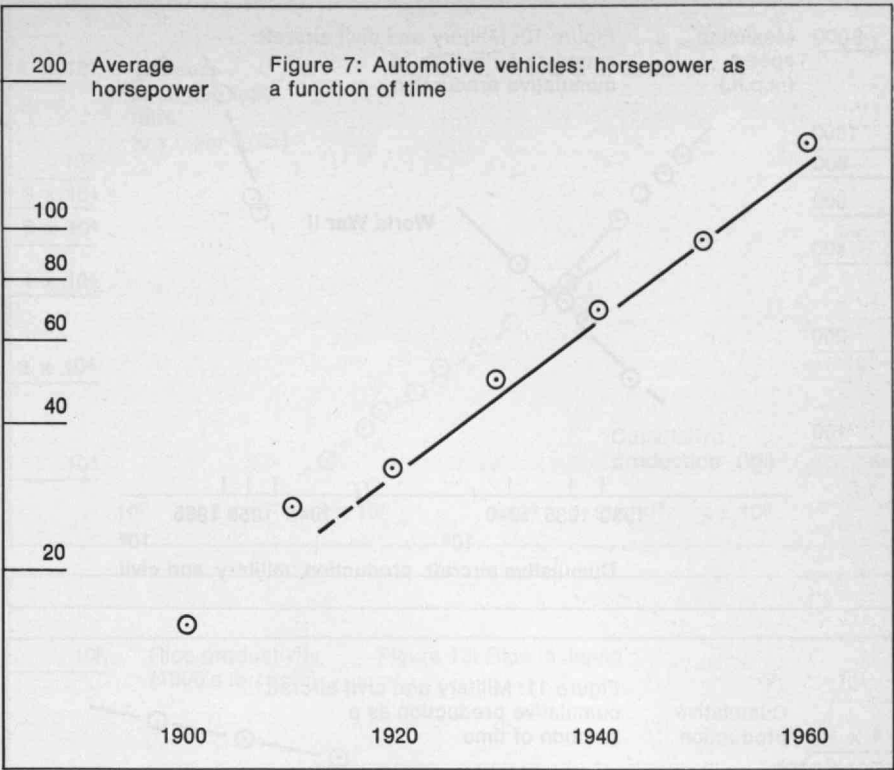
**Civil Aircraft**—Taking maximum

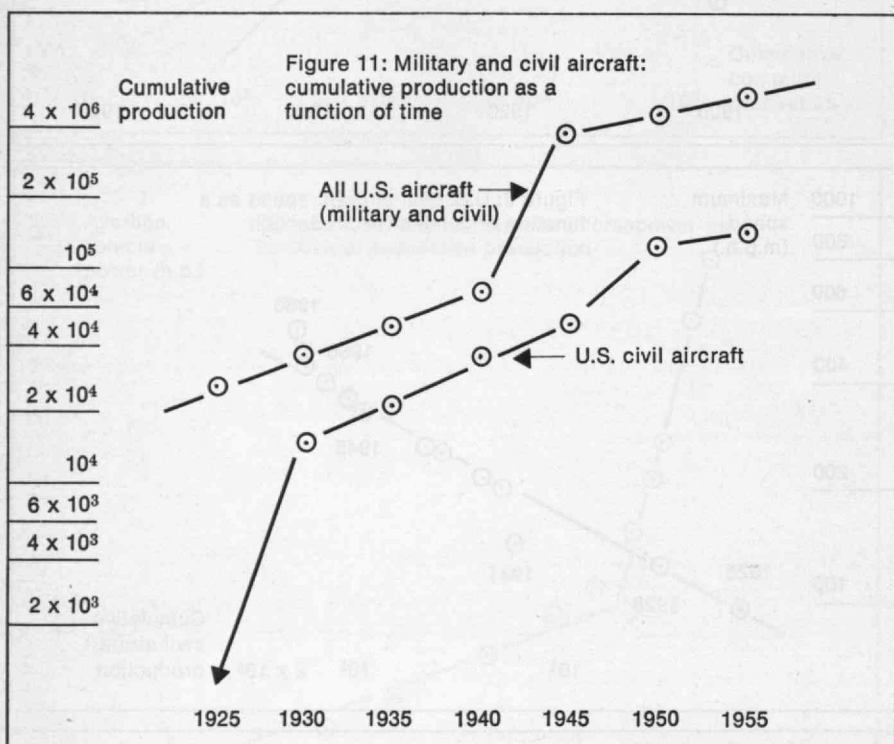
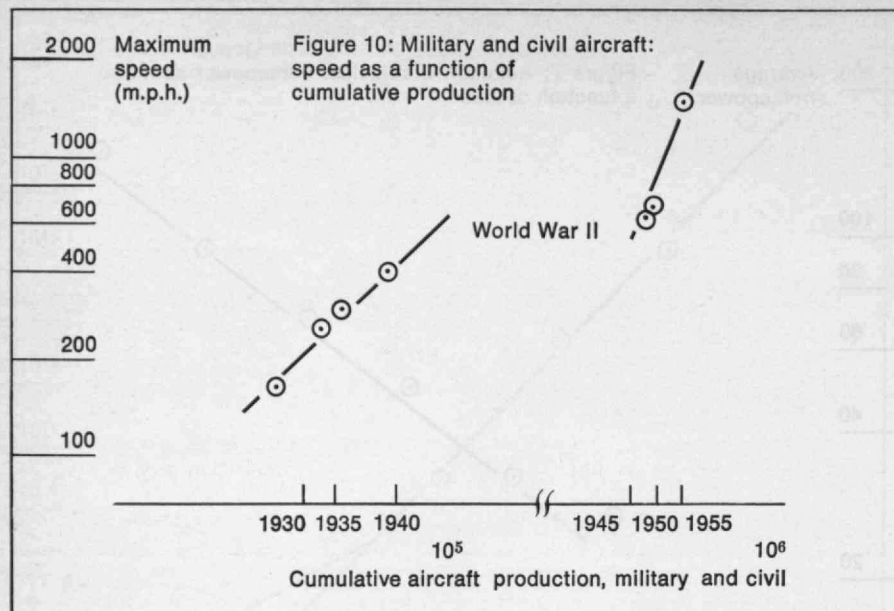
speed as a technological measure of progress in civil aviation, we find once again that a technological progress function exists (Figure 8) and that it is a striking improvement over the traditional forecasting plot (Figure 9). Apart from one very low point (which is for the Depression year 1931) there seems to have been no change in the rate of progress, implying a constant environment. And, indeed, there really have been no important changes in the factors affecting the civilian aircraft industry. Speed has remained a desirable factor to improve (up to the present, anyway) and in the period studied there have been no major new influences on the market analogous to those we find in automobile history—unless, which is a possibility, the introduction of the jet engine has recently made air travel into a qualitatively different product, and thus is altering the market in the way that better tires affected the auto market.

**Military Aircraft**—The data regarding military aircraft exhibit three characteristics of major interest. One is additional evidence for the existence of a technological progress function (Figure 10).

The second is the indication of what may be a fundamental point concerning the “learning” that is derived from experience. The somewhat counter-intuitive lack of progress during the war years could mean that a sudden increase in production may have no corresponding effect on technology if the rate of production exceeds some maximum for the people and organizations involved. This may be particularly true when—as in this case—production is “uncoupled” from the market research system of which the production process is normally a part. Production figures for aircraft are shown in Figure 11. Note that the two periods of rapid growth in civil aviation (1925-30 and 1945-50) were not accompanied by a leveling-off of their progress functions, but the very abrupt wartime burst of military production was.

The third aspect of the data to be noted in Figure 10 is that the production figures used are for civil plus military aircraft, whereas Figure 8, for civil aircraft, uses only civil aircraft production. In preliminary studies, it was found that the military speed data plotted against





only military production did not give good linearity. A possible explanation could be that military development has access to both classified and public knowledge, and hence "learns" from both sources, whereas private development cannot use military knowledge. This conflicts with the usual view—that civil aviation progresses by applying military precedents—although not with the picture of the current V./S.T.O.L. situation presented by C. W. Harper and Hans Mark (Technology Review, May 1972, pp. 22-30). The truth is perhaps that, while military technology demonstrates what performance is tech-

nically conceivable, the rate at which such demonstrated innovations enter the real market-place is still limited by myriad details of know-how relating to purely commercial situations.

**Titanium**—This example is chosen to illustrate the variety of performance parameters that may be characterized by a technological progress function. One important changing characteristic of titanium is its production cost, which has been a major factor in decisions whether or not to use it. Another key factor is the strength of titanium, which depends on the techniques used in

preparation, so that cost and strength are interrelated. It makes sense, therefore, to take as a measure of technological progress the pressure at yield point, measured in pounds per square inch, divided by the unit cost of the titanium.

The results (Figure 12) are of interest simply because they further demonstrate the existence of the technological progress function, and because they show that our concept is valid for a reasonably constructed composite parameter which has an economic as well as an engineering dimension (whereas figures-of-merit used as progress parameters in other studies have been concerned only with engineering characteristics).

### An Agricultural Revolution

One might get the impression from the foregoing that the progress functions apply only to items of industrial hardware. This is not so, as is shown by studies in the totally different area of agricultural efficiency. Using information on the amount of rice produced per acre in Japan over a period of twelve hundred years, the lines that we hope for appear when the logarithms of both productivity per acre and cumulative harvest are taken (Figure 13).

Before commenting on this result, it may be of interest to mention how these data were obtained. First, this kind of information happens to be available because land under cultivation and amount of rice produced have been the traditional methods of tax assessment in Japan, except for the last hundred years. Records of such tax information have been preserved by many centuries of Japanese emperors, and acreages have been tabulated by W. W. Lockwood. Combining these with information assembled by H. Kahn and A. J. Wiener on changes in production efficiency (as measured by pounds of rice produced per acre) it is possible to compute cumulative production figures and hence to plot a technological progress function.

There are two major trend lines, ancient and modern, the latter at a much steeper slope. They intersect at a point coinciding with a period of great environmental external change—the "opening of Japan," 1854-1868, of which Lockwood writes:

"The modernization of Japan after

1868 has been likened to the bursting of a dam. It was the more violent because it brought the release of long pent-up forces . . . In part these pressures were economic in character.

" . . . there set in a feverish process of modernization. Japan was now exposed to a rising tide of Western influence. Foreign trade more than doubled in volume in the first decade after 1868."

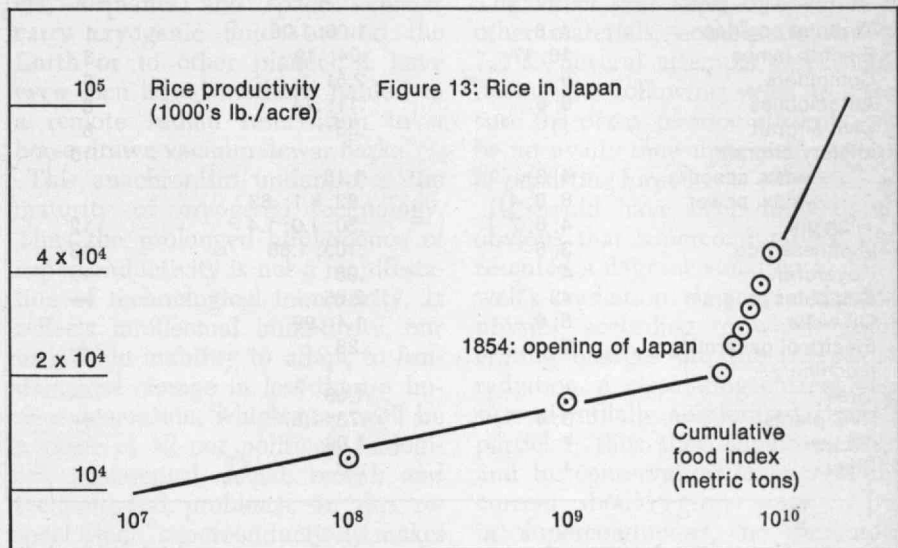
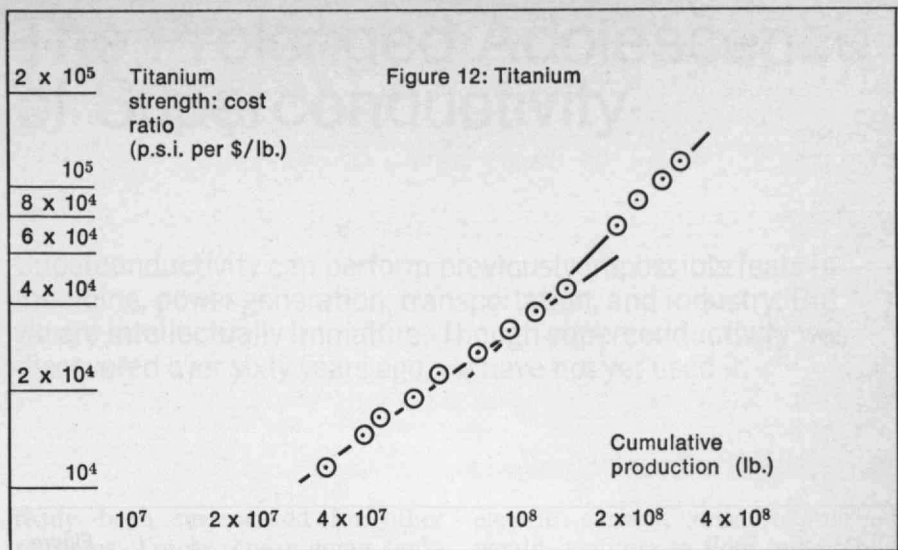
"More and more the Japanese people were now specializing their economic activities to produce surpluses for sale in the commercial market. . . . The shift of employment to manufacturing and the service trades was able to proceed as it did only because primary production also expanded . . . (Agricultural growth) made it unnecessary to import large quantities of food to support growing city populations.

" . . . [the growth in agricultural efficiency] resulted from more fertilizer, better credit facilities, double cropping and other more intensive methods of farming.

Thus, a whole system of interrelated changes occurred in Japan at this time; in those few years, the essential nature of "modern" Japan's environment was established, and subsequent changes have been, in comparison, minor. The shift in the technological progress function reflects this transition from an isolated, feudal, agrarian state to the growth-oriented fast-learning nation of the past century. To a first approximation, the periods before and after the 1860s both have constant technological progress gradients, although differing by an order of magnitude.

### The Technological Progress Function

Other cases studied likewise unearthed similar linear technological progress functions—linear when the logarithm of the technical progress parameter is plotted against the logarithm of cumulative production. Those cases not discussed here are hovercraft (using a Navy figure of merit as the technological measure), the development of a computer program (figure of merit), military aircraft (maximum horsepower), oil wells (feet/day drilled by each rig), electric generating machinery (specific fuel consumption), automobile tires (tread-wear rating), polyvinyl-



chloride plants (maximum capacity), oil tankers (maximum size), and steel (yield strength). The statistics for all our case studies are summarized in the table on page 38.

Thus, the data tend to support the conclusion that technological progress functions exist and are of the same form as M.E.P.F.'s and learning functions. When environmental factors vary, there is the suggestion that the rate of progress may undergo discrete shifts.

Such a technological progress function, would take the form

$$T(i) = ai^b$$

where  $T$  is the parameter of technological progress, and  $i$  is the cumulative production.

Let us examine the constant  $b$  that we have suggested is an indicator of the rate of progress, and is affected by the environment.

Though  $T(i)$  is evaluated at integral values of  $i$ , we can assume it to be a continuous function, and take its derivative with respect to  $i$ .

$$\frac{dT}{di} = abi^{b-1}$$

We convert to differential notation, divide both sides by  $T$ , and cancel like terms.

$$\frac{dT}{T} = b \frac{di}{i}$$

Now,  $dT/T$  can be seen as a fractional change in the parameter that measures technological progress, and  $di/i$  is a fractional addition to the cumulative production.

So we see that as long as  $b$  holds constant, which means, according to the theory, that environmental changes pertinent to the technology in question do not take place—the percentage change in a technical parameter should be proportional to the percentage change in cumulative production. This is exactly the relation found, though empirically and not quantitatively expressed, by Gilfallen and Schmookler.

As we promised earlier, we will now look at how our technological

Case title	Sample size	Progress constant	Figure in text
Turbojet engines	4; 6	1.06; 1.06	1
Electric lamps	10; 17	.04; .19	3
Computers	5	2.51	5
Automobiles	6; 6	.11; .74	6
Civil aircraft	11	.33	8
Military aircraft			10
—max. speed	4; 3	1.18	
—max. power	8; 6; 4	.83; 6.1; .83	
Titanium	4; 8; 7	.30; 1.0; 1.4	12
Japanese rice	3; 6	.103; 1.88	13
Hovercraft	4	.98	—
Computer program	42	2.65	—
Oil wells	5; 6	1.4; .99	—
Electrical generating machinery	6	.28	—
Tires	5	1.09	—
PVC plants	3; 4	.73; 1.67	—
Oil tankers	7	1.08	—
Steel	4	.63	—

progress function relates to the traditional technological forecast,

$$T = Ke^{ct}$$

in which progress is simply a function of time. Going through the same mathematical steps for the traditional forecast, we get:

$$\frac{dT}{T} = cdt$$

If our progress function and the traditional forecast both produce the same result, then  $dt/T$  must be the same for both. Thus we equate:

$$cdt = \frac{b}{i} di$$

or, shuffling terms:

$$\frac{di}{dt} = \frac{ci}{b}$$

where  $c$  and  $b$  are constants.  $\frac{di}{dt}$  is the time-rate of production. We see that the two versions of progress will agree if and only if the rate of production is a constant fraction of the total production to date. And that is exponential growth.

In an industry in which growth is exponential, the technological progress function will give the same results as the time-function generally favored by forecasters hitherto. This occurrence I call "the substitution effect." For any given analysis, this effect may be present throughout all, part, or none of the period being considered. And it may be present to a varying degree. I contend that most forecasting studies completed to date may have been accurate (in so far as they have been) largely because of this effect.

A partial substantiation of this claim has been derived from reconsidering the data on civil aircraft (1925-1947), automotive vehicles (1930-1968), and turbojet engines (1945-1965). It was found that where growth in production approached the pattern of a constant annual percentage rise (as in the case for the jet engines), the technological parameter conformed to both a technological progress function and to an exponential function

of time. But automobiles did not conform very well to a traditional forecast, though they did to a technological progress function. Civil aircraft did not conform at all to a time-trend, but did to a technological progress function. The lack of conformity to a time-trend in the latter cases was highly correlated with the absence of the substitution.

Now, given that technological progress relates to cumulative production, what does this mean? It is not entirely clear why the technological progress function works as well as it does. Obviously, production alone does not produce technological change—although without it there is little incentive for improvement. Learning, invention, and other familiar processes are all involved, and improvements can come not only from the production facilities but from sources outside the industry (including independent inventors), and from formal research and development. For the moment, I conclude that cumulative production is serving as a very good dummy variable, representing a host of other variables. It is probably this characteristic of the industrial market-research system that is most closely related to the stimulation, control, and rewarding of the human activities that contribute to technological progress.

#### Author's Note

A more detailed version of this article, containing data sources and references, is available from the author. Interested readers are also referred to *The Rate and Direction of Inventive Activity*, Richard Nelson (ed.), Princeton, 1962; and "Surveys in Applied Economics: Technical Progress," by Kennedy and Thirlwall, in *Economics Journal*, March, 1972.

# The Prolonged Adolescence of Superconductivity

Superconductivity can perform previously impossible feats in medicine, power generation, transportation, and industry. But we are intellectually immature: Though superconductivity was discovered over sixty years ago, we have not yet used it.

The 12-gage copper wire which feeds a standard electric outlet will carry a current limited to 20 amperes by resistive heating. A wire of the same size made of commercially available superconducting material and kept at the temperature of liquid helium will carry a current of 50,000 amperes without any significant resistive loss. It seems evident that superconductivity represents a breakthrough comparable in many ways to the invention of the wheel: it offers the frictionless transport of electricity in quantities heretofore inconceivable, and the loss-less generation of magnetic fields of intensities and sizes beyond all previous hope of economic feasibility.

But the most remarkable fact about superconductivity is that sixty years after its discovery it has still not come of age. Superconductivity has yet to be applied to one single purpose which affects everyday life! Considering the maturity of aviation sixty years after its inception, we cannot help marvelling at the prolonged adolescence of superconductivity.

To be sure, formidable technological obstacles stood in the way of its practical application, related mostly to the maintenance of a low-temperature environment. But these obstacles were no more formidable than those faced by the wheel and the aeroplane at the time of their invention, and in fact they have al-

ready been surmounted for other purposes. Trucks, ocean-going tankers, airplanes and space vehicles carry cryogenic fluids around the Earth or to other planets; I have even seen liquid methane hauled to a remote Indian reservation in a horse-drawn vacuum dewar flask.

This anachronism underscores the maturity of cryogenic technology. Thus the prolonged adolescence of superconductivity is not a manifestation of technological immaturity. It reflects intellectual immaturity, our incredible inability to adapt to fundamental change in less than a human generation, which may well be a cause of all our political, ecological, economical, social, moral, and technological problems. In this respect alone, superconductivity makes a very interesting case history.

## Macroscopic Quantum Mechanics

In 1908 Kamerlingh Onnes at the University of Leiden in Holland succeeded in liquefying helium, thereby extending the temperature range available for experimentation from 20.3°K, the boiling point of hydrogen, to 4.2°K, the boiling point of helium, and ultimately even lower. (The Kelvin, or "absolute" temperature scale is divided into degrees equal to those of the centigrade scale, but 0°K is the absolute zero of temperature, the point at which molecular motion ceases. 0°K corresponds to -273°C or -460°F.)

In 1911, just three years later, Onnes accidentally discovered superconductivity while exploring just how far the resistivity of a pure metal would drop with temperature. Mercury was the purest metal then available; its resistance to current flow leveled off at 14°K, but at 4.2°K—by chance the boiling point of helium—it abruptly vanished. An

electric current, once established, would continue to flow indefinitely. The effect was soon discovered in other materials, notably in lead at 7.2°K. Several attempts were made during the following years to measure the decay of supercurrents, but to no avail: they appeared capable of persisting forever.

It should have been immediately obvious that superconductivity represented a flagrant violation of Maxwell's radiation law of classical physics, according to which accelerating charges are the sources of radiation. A circulating current consists of radially accelerated charged particles; thus they should radiate, and by conservation of energy, the current should grow weaker. But in superconductors, no resistance meant no loss of current.

Thus superconductivity seemed to be the appearance on a macroscopic level of something like the phenomenon on the microscopic scale of the atom that intrigued Bohr: the fact that an electron could revolve around the nucleus of an atom without radiating energy and eventually collapsing into the nucleus.

As early as 1912, Bohr invented quantum mechanics in order to cope with the electron which orbits around a proton in a hydrogen atom. By the twenties, the laws of quantum mechanics were firmly established and universally taught. Yet superconductivity was not related to them until the mid-thirties, when Fritz London, a German physicist working in England, first pointed out that superconductivity must represent a macroscopic manifestation of quantum behavior. This announcement should have galvanized a generation of physicists, who, by then, had a thorough education in quantum mechanics. However, the

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concepts had obviously not as yet been assimilated intellectually, because London's revelation was generally ignored, by all except several individuals who did pursue his insight.

It was only in the late fifties and early sixties that a new generation of physicists managed to cope with the challenge and made the first intellectual breakthrough. Several effects were discovered. The first good theory emerged, that of Bardeen, Cooper and Schrieffer, "good" in the sense that it explains superconductivity on the basis of first principles, but it still fails to relate it to atomic or molecular structure. This may be uncharitable oversimplification, but since their theory cannot explain why a given substance is a good or bad superconductor, it is a fact that even after ten more years, researchers looking for new superconducting materials are still forced to rely on the methods of seventeenth century alchemy.

### The Privilege of Cryogenics

Progress was equally slow on the practical front; in fact, none was attempted for forty years, because superconductivity was considered a laboratory curiosity without the slightest practical potential. For one thing, the liquefaction of helium was an elaborate ritual, a laboratory tour-de-force. Large supplies of liquid helium seemed unthinkable. It was only in 1949 that Sam Collins of M.I.T. unveiled the first continuous helium liquefier, and I vividly remember the disbelief with which a group from the University of Leiden viewed this machine. A remark made by Prof. Gorter, head of their Kamerlingh Onnes Laboratory, on this occasion provides an interesting insight into the sort of

attitude which impeded progress: "At Leiden we believe that a man should earn the privilege of working at helium temperature! Now anybody will be able to do low-temperature research! This is preposterous!"

The superconductors discovered initially, all of them pure elements, were not very good. Superconductivity is confined by a three-parameter trade-off to the inside of an onion-shaped region of temperature-field-current space, meaning that superconductivity is destroyed not only by a rise in temperature, but also by a rise in the applied magnetic field or a rise in the current being conducted. Early superconductors would generate only several hundred to perhaps two thousand gauss, the sort of field intensity produced by permanent magnets, and they would carry no more current per cross sectional area than normal conductors.

The advent of the Collins liquefier inspired three applications in the fifties. The superconducting bolometer, a device to measure minute changes in heat, was developed at Johns Hopkins Applied Physics Laboratory; a superconductor on the verge of its transition to the normal nonsuperconducting state made a very sensitive, though cumbersome, radiation detector. The other two applications came from M.I.T.: Dudley Buck of the Electrical Engineering Department developed the "cryotron," a superconducting binary memory element capable of flipping between the normal and superconducting state, and Stanley Autler of M.I.T.'s Lincoln Laboratory built a superconducting magnet for tuning the maser used in the 85 foot dish of the Millstone radio telescope antenna in the historic first

radar contact with Venus. There was general amusement at the suggestion of a helium cryostat in the Millstone dish; but it turned out to weigh only 75 pounds, complete with an eight hour helium supply. The permanent magnet built "just to have a reasonable back-up to the hare-brained scheme" tipped the scales at 1,500 pounds.

The first practical breakthrough came in 1960, when John Kunzler of the Bell Telephone Laboratories succeeded in making wire of niobium-tin ( $\text{Nb}_3\text{Sn}$ ), a brittle intermetallic compound which remained superconducting to 18°K (within 2 degrees of the hydrogen boiling point), 200 kilogauss (a field intensity generated by conventional magnets only at the M.I.T. Francis Bitter National Magnet Laboratory) and the incredible current density of a million amperes/cm<sup>2</sup>. The onion of superconductivity had exploded: superconductivity could accomplish previously impossible things. Its practical value seemed assured.

A frenzy of research soon led to other superconducting materials, including intermetallic compounds such as vanadium-gallium ( $\text{V}_3\text{Ga}$ ) and vanadium-silicon ( $\text{V}_3\text{Si}$ ), and alloys such as niobium-titanium and niobium-germanium-aluminum. Microstructure proved to be crucial: the superconductors had to be in finely divided filaments, achieved by co-extrusion in a matrix of normal metal (copper, aluminum), vapor deposition in multiple layers interspersed with normal material, or impregnation of a substrate of porous glass filaments. It is an interesting question why alloys and compounds arrived only half a century after the discovery of elemental superconductors, considering that it has been known since antiquity that the prop-

There is a widespread belief that superconducting magnets are impractical, that they must be immersed in huge vats of boiling helium. But in fact, they can be maintained with the ease and reliability of a refrigerator.

erties of an alloy are very often superior to those of any of its components.

Incredible as it may seem, all these developments were followed by an international slump. The new materials were used only by a handful of high energy physics laboratories, and in all cases for reasons of economy rather than innovation. The management of companies such as G.E., Westinghouse, R.C.A. and comparable ones abroad wondered, with justification, whether a multi-million dollar investment in materials technology had been foolish, or merely premature.

### State of the Art

For about five years now, an impressive array of superconducting materials has been awaiting a market which has not developed. The reasons seem more psychological than technological. There is a widespread belief, for instance, that superconducting magnets must be almost inaccessibly immersed in a huge vat of boiling helium, requiring constant replenishment and always on the verge of explosive evaporation. It is true that some very large bubble chamber magnets, notably those at Argonne and Brookhaven, have been cooled by immersion in boiling liquids (as were some of the early gasoline engines). But the practice constitutes a completely unwarranted extrapolation of table-top technique, excusable only on the grounds that these magnets were built for physicists without any incentive for technological innovation. Eight years ago the effectiveness and stability of a forced circulation system using liquid helium above its critical pressure, where boiling is impossible, was demonstrated at the Bitter National Magnet Laboratory.

The technique has since been applied to three magnets by Mario Morpurgo at CERN, the most recent being the OMEGA bubble chamber magnet, one of the largest in the world. Its pancake coils are protected by only a radiation shield and vacuum barrier, and cooled by closed-cycle refrigeration, like a kitchen refrigerator which uses, but does not consume, its freon. Thus the scarcity of helium is no obstacle to the widespread use of superconductivity.

The state of the art can be summarized by saying that the thermal environment for a superconducting magnet of any size can now be maintained with the ease and reliability of a kitchen refrigerator, and at a cost of one kilowatt per ton of superconducting magnet.

### A Stunt to Hasten Maturity

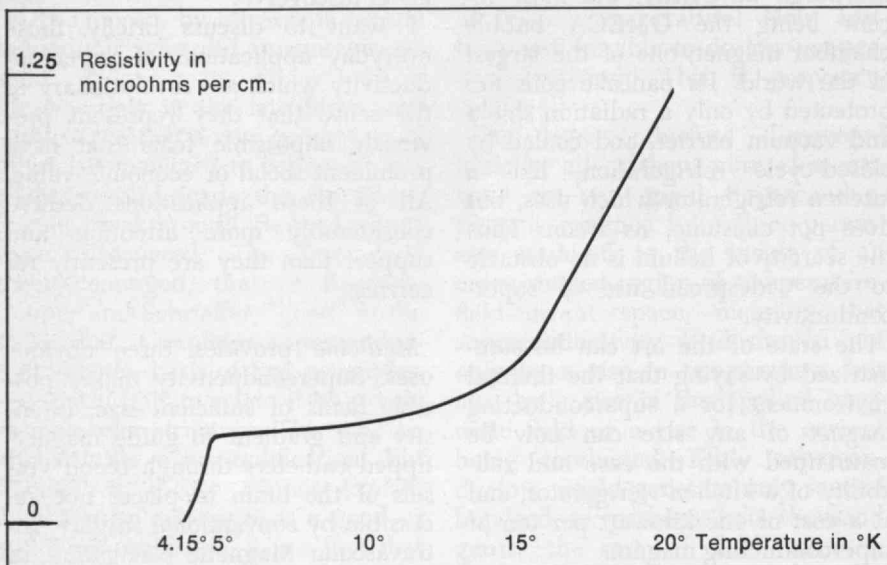
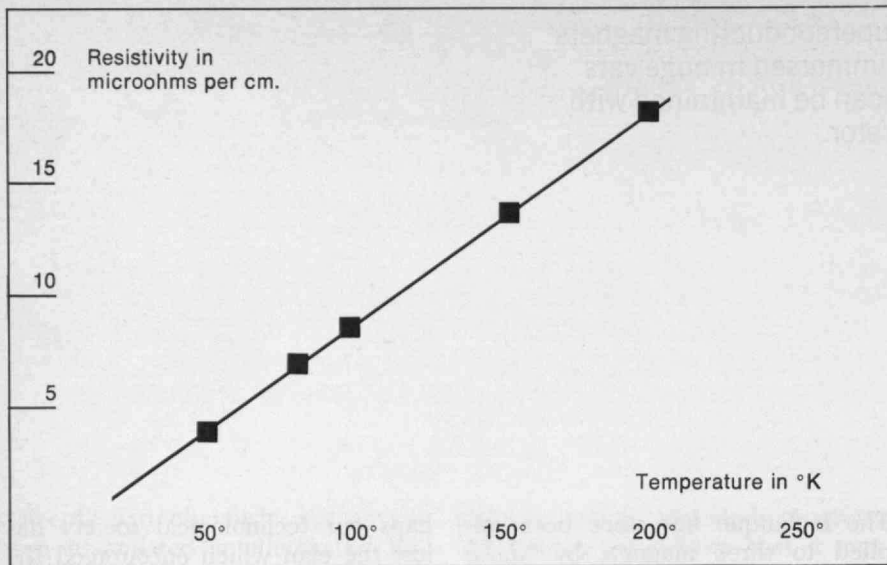
Prolonged though the adolescence of superconductivity has been, there are signs that it is coming to an end. What is needed more than anything else to hasten progress is an event comparable to one which occurred in aviation at about the same point in its development: Lindbergh's non-stop flight to Paris. It was not a feat of technological innovation; the hardware he used had been commercially available for years. Nor, for that matter, was it a commercial breakthrough. Yet it did more than any amount of wind tunnel testing and economic analysis could have done to bring about the acceptance of aviation as an everyday means of travel. Several people around the world, myself included, have been trying for some time to pull off a Lindbergh stunt in superconductivity, but for some reason it has not yet come to pass. Perhaps we lack Lindbergh's flair for drama; or per-

haps our technological society has lost the elan which encouraged the joy of discovery.

I want to discuss briefly those everyday applications of superconductivity which are revolutionary in the sense that they represent previously impossible feats that have prominent social or economic value. All of these applications deserve considerably more attention and support than they are presently receiving.

*Medicine* provides three obvious uses. Superconductivity makes possible fields of sufficient size, intensity and gradient to guide magnet-tipped catheters through blood vessels of the brain to places not accessible by conventional surgery. Intravascular Magnetic Navigation, as this new technique is called, has already been demonstrated at the Massachusetts General Hospital in four actual operations in which aneurisms, or blood vessel failures, were successfully sealed. Conventional electromagnets adequate to perform this operation would require many times the power available to even the largest hospital. Considering the relatively minor investment required to develop this new surgical tool, it is hard to understand why it has taken three years for the proposal to receive serious consideration.

Superconductivity also offers magnetic fields of sufficient size, intensity, homogeneity, and constancy to perform nuclear magnetic resonance measurements on an entire patient. According to recent observations, this might provide the first positive means for diagnosing the presence of cancer tissue, on the basis of its characteristic nuclear magnetic resonance spectrum. Conventional



Resistance to flow of electricity is shown for mercury in a temperature range where it is a solid—below its melting point, 234 degrees Kelvin. Through virtually all of this range, Kamerlingh Onnes, working in 1911, found a straight

line. But as he cooled mercury closer to absolute zero, resistivity first levelled off—and then suddenly vanished. Onnes had discovered a new state of matter—the superconducting state.

magnets fail to provide the field strength required for sufficient spectral resolution. So far, there has not yet been a facility created to explore this possibility even in small animals.

Electron microscopy provides an application already being pursued commercially, particularly in Japan: superconducting magnets can focus a beam of high energy electrons sufficiently so that electron microscopes can have the resolution required to see the structure of genetic material. They will also permit microscopy at higher electron energies, where less tissue damage occurs.

*Metallurgy* is overdue for a rather

spectacular application. For about ten years, pulsed magnetic fields have been used to perform several metal forming operations. It has become standard practice to swage aircraft control cables to their connectors magnetically, because induced eddy currents accomplish this more reliably than mechanical dies. In a continuous background field of the intensity and size which can be provided by superconducting magnets, pulsed current metal forming can be applied to many new operations, including high speed production and compound forming of large honeycomb panels which would be crushed by conventional forming presses.

*Magnetic Separation* has been practiced in the mining industry for several decades. It relies on a force which is proportional to the magnetization induced in the particles being separated, the size of those particles, and the gradient of the applied field. The practitioners of this art are not really aware of the innovations in magnet technology which have occurred in physics laboratories during the past two decades. Magnetic separation has therefore been limited to a few primitive applications, such as the separation of iron ore of relatively large particle size, or the removal of tramp iron (shards that break off food processing machinery) from processed food.

Only three common elements are ferromagnetic, whereas a very large number of materials, most oxides included, are paramagnetic. Paramagnetic materials are not normally considered magnetic because it takes greater field strength than that available from an ordinary magnet to magnetize them appreciably; but on the other hand, they don't saturate magnetically: their magnetization increases linearly with applied field. We have found that with some sophisticated magnet technology, even without superconducting magnets, it is economically possible to magnetize many common paramagnetic materials sufficiently to permit their separation from a less magnetic mixture. If a high field gradient is provided, the method is applicable even to particles of colloidal size.

High gradient separators, as they have come to be known, are already being used in one area of the mining industry: they purify kaolin (used for paper coating) by removing colloidal impurities which are about 10,000 times less magnetic than iron. Spectacular though this performance may be, its implications have not as yet been appreciated. In the battle against entropy, which after all is the battle of life, we have only very limited means for manipulating small particles on a large scale: filtration, flotation and electrostatic separation. When a mineral is too finely dispersed in a host material for any of these methods to separate it out, it is useless. When water is polluted by suspended solids, it is worse than useless. Magnetic separation now provides us with a more widely applicable method for the large-scale manipulation of colloidal

Superconducting electric generators are one tenth the size of conventional machines, and superconducting power lines can carry ten times more power over ten times longer distances.

particles.

Let me cite several examples we are now pursuing at the National Magnet Laboratory, in cooperation with Magnetic Engineering Associates, the Cambridge firm which built the high-gradient separators being used in the kaolin industry. Coliform bacteria, as well as many dissolved and suspended nutrients, can be removed from water by seeding it with colloidal iron oxide and passing it through a high-gradient separator at flow rates about 100 times higher than rates associated with filtration. This makes it possible to effectively decontaminate sewage and industrial waste that we cannot now afford to treat, and to entertain realistic dreams about decontaminating natural bodies of water we have already ruined. It has also become possible to remove much of the sulfur and fly-ash components from pulverized coal in a way that suggests the possibility of an economically feasible large-scale process. Most finely divided metal oxides, currently being discarded on tailing piles, are sufficiently paramagnetic to be recovered by high-gradient separation.

One of the most promising applications involves iron ore. About ten years ago the Mesabi Range, backbone of the Great Lakes iron industry, was exhausted. The only remaining ore was taconite, too finely divided for use in blast furnaces. Disaster was averted by the invention of pelletizing. The taconite was finely ground and concentrated by hundreds of magnetic drum separators, in what was by far the largest application of magnetic separation in the world. The powdered ore concentrate thus obtained was fed into blast furnaces in the form of fired pellets. But a new crisis is facing the

Mesabi Range: reserves of magnetic taconite are running out, exposing vast quantities of a more highly oxidized ore rich in goethite, called "semi-taconite" or "non-magnetic taconite," which cannot be concentrated by any known economically feasible method. Laboratory tests with high-gradient separators show promising results, and the first continuous pilot plant machine is currently being tested. It uses conventional electromagnets, as do the relatively small kaolin machines. However a full-scale taconite concentrating plant would be unthinkable without superconducting magnets, despite the fact that the mining people still view the suggestion with more amusement than interest. Operating a battery of superconducting magnets in northern Minnesota would be a tour de force comparable to Lindbergh's.

*The Power Industry* offers the most massive potential applications of superconductivity, both long-range and immediate. The long-range applications include magneto-hydrodynamic (MHD) power generation, and controlled thermo-nuclear fusion.

MHD may be regarded as the first real advance in combustion technology since Prometheus gave man fire. It is based on recognition of the fact that combustion is in reality a plasma process involving charge transfer in a "gas" of charged particles, even though it has always been treated as if it were a purely chemical process. It is possible to extract electrical energy directly from combustion by performing it in a magnetic field, and superconductivity makes the required field economically possible.

Fusion, the energy source of the

stars, would solve our energy crisis forever without generating radioactive waste products. In stars, the hot plasma particles are confined by gravitational force. On earth, magnetic fields can confine a plasma by forcing the charged particles to move only along magnetic field lines. Only superconductivity can make fields of the required intensity economically feasible.

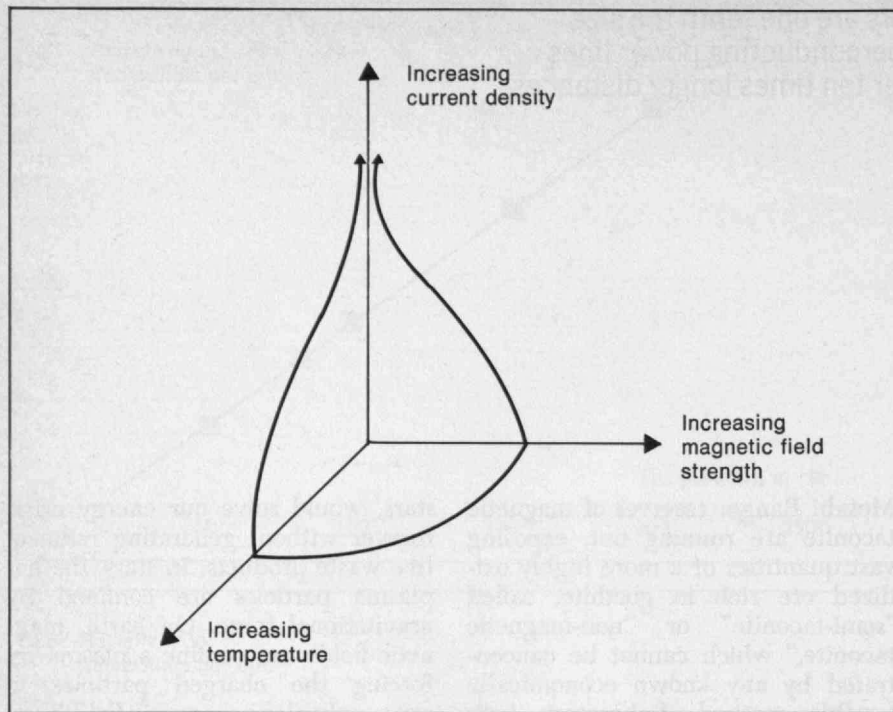
Both MHD and fusion are still in the realm of research, although MHD is much closer to realization.

Superconductivity also has more immediate applications, which can be summed up in two sentences. Superconducting motors and generators are about one tenth the size of equivalent normal machines. Superconducting power transmission lines can be made to carry ten times more power over ten times longer distances than the largest economically feasible conventional transmission lines.

Superconductivity therefore offers a ten-fold decrease in capital cost, the predominant cost of power. It also offers the possibility of generating power in larger units (present machines having reached the mechanical limit of size), and at locations chosen to minimize environmental damage.

There are basically two types of superconducting generators.

Alternators depart from traditional machine design by having rotating superconducting field windings on the inside, and a stationary normal armature on the outside. Of course, the stationary armature will eventually be superconducting if the machine is designed to connect to a superconducting power line. Woodson, Smith, and Thullen at M.I.T., who pioneered this type of generator and built a 45 kW machine, find



The "onion of superconductivity," a region defined by a three-parameter trade-off, within which a substance is superconducting, and outside of which it is not. There are critical values, different for each superconducting substance, of temperature and magnetic field strength; if they are exceeded, superconductivity ceases. But the third parameter, current density, has no critical value—it can be increased as the other two

parameters are made to asymptotically approach zero. Thus the onion's shape is defined.

The problem with current theories of superconductivity, the author says, is their failure to predict which substances will make better superconductors, will make the onion of superconductivity explode.

that the rotating liquid helium seal turns out to be a problem easily solved once its inevitability has been accepted. It constituted an insurmountable psychological obstacle to many people for many years.

DC machines, the second type, are of the homopolar type, also called "acyclic," that was invented by Faraday, and are also known as the Faraday Disk Motor although modern versions may use cylindrical instead of disk rotors. Appleton of the International Research and Development Company in Newcastle built the first practical machine with superconducting field windings and a normal rotor—the so-called Fawley Motor, with a rating of 3,250 hp. Finnieston of I.R.D. and the Ministry of Technology deserves at least equal credit for promoting the project several years ago; it is unquestionably the nearest thing to a Lindbergh stunt realized so far, and has certainly made a profound impact on the creditability gap.

As a result of these efforts, miniscule in comparison to the importance the society should have at-

tached to them, superconducting machinery is finally being taken seriously in many quarters, but nowhere as seriously as in our most sophisticated industry, the war industry. Superconducting propulsion motors one tenth the size of conventional ones make turbo-electric systems feasible for even the smallest naval vessels and hydrofoils, and give larger ships a decisive competitive advantage in "mission effectiveness." Marine engines are being vigorously developed in all the advanced countries and may well turn out to be the first practical application of superconductivity.

*Transportation* offers one of the most surprising applications. Superconductivity may ultimately replace the wheel, thereby giving prophetic significance to my initial analogy. Unfortunately transportation also provides a very sad example of damage which has already been done by the prolonged adolescence of superconductivity.

Wheeled trains become impractical above 130 or 150 m.p.h. due to the

inevitable imperfection of rails, a circumstance verified by the Japanese in their operation of the New Tokaido Line. Since air traffic is reaching saturation on many routes, there is need for fundamental innovation on the ground.

On the basis of elaborate studies done in the mid-sixties, the U.S. Department of Transportation decided about four years ago to follow the French lead in developing tracked air cushion vehicles. Two German industrial teams, Krauss-Maffei and Messerschmitt-Bölkow-Blohm, started at about the same time to develop magnetic levitation systems based on the attraction of conventional electromagnets riding below a steel rail, an inherently unstable system which is stabilized by feed-back control at considerable cost in control power as speed is increased. Both of these approaches now turn out to be dead ends for a variety of reasons, but primarily due to the fact that they operate at such small clearance gaps as to provide very little advantage over the wheel. They simply will not go much faster than wheels, and they cost a great deal more. It thus appears that the D.O.T. decision to back tracked air cushioned vehicles using conventional magnetism is somewhat analogous to a decision in 1920 to back airships and ignore aeroplanes, which were then in their adolescence. The decision might not have been made, had superconductivity been more widely known and understood.

As early as 1966, Powell and Danby, two magnet technologists at Brookhaven, pointed out the advantages of repulsive levitation systems made possible by superconductivity. Several other studies followed, but all of them were too academic to be taken seriously. The mistake of ignoring superconductivity has now become obvious. A third German team, Siemens-AEG-Braun-Boveri, is actively developing superconducting levitation, and the Japanese are well along in a multi-million dollar program involving Hitachi, Toshiba and Mitsubishi, with partial support from the National Railway; they are scheduled to have several miles of a superconducting system operating at high speed by 1976.

Our own Department of Transportation, on the other hand, has only just now recognized that superconducting levitation systems are tech-

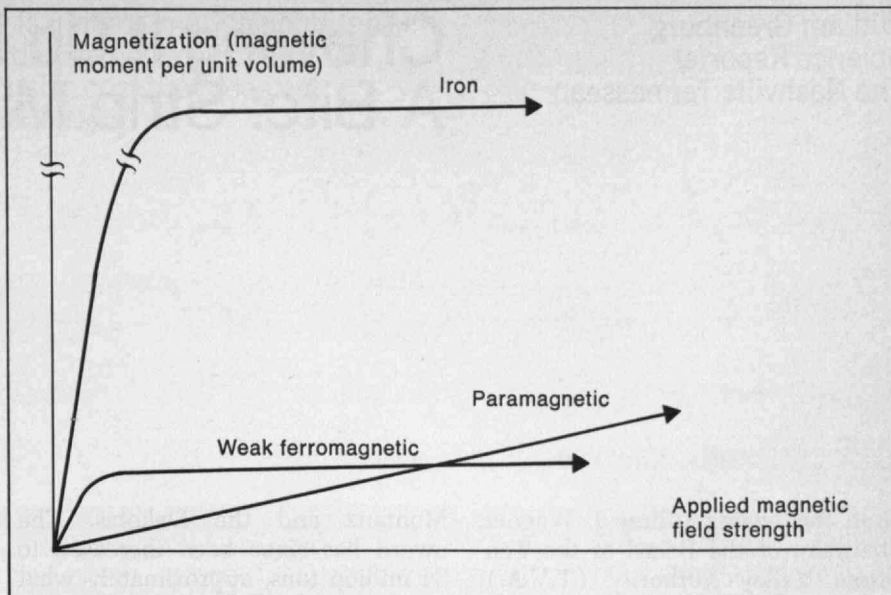
nically feasible, and has not yet shown evidence of believing that superconductivity might indeed represent the winning approach to providing both lift and propulsion for high speed ground transportation. If superconductivity does indeed prove the winner, as the Japanese have concluded, then we are forfeiting world leadership in one of the prime technological markets of the next several decades, a market which is vital to our entire aerospace and electronics industry.

The irony of this situation is that we possess unquestioned competence in magnet technology, superconductivity, cryogenic engineering, power conditioning, vehicle dynamics, aerodynamics control technology, systems engineering and all the other areas involved. For lack of leadership, however, we have failed to mount the broad interdisciplinary effort required. That sort of effort is customarily lavished on weapons systems.

### The Magneplane

Richard Thornton of the Electrical Engineering Department and I started to take a serious look at the overall problem about two years ago, and have developed what we think represents the ultimate contribution of superconductivity: guided electromagnetic flight. As the term suggests, the motion of a magnet above a non-magnetic, conducting surface is in many ways the electromagnetic analog of aerodynamic flight: lift is produced at the expense of drag, and the lift force is sufficiently resilient so that the vehicle's trajectory is essentially governed by its inertia. Contrary to aerodynamic flight, however, electromagnetic flight can be guided because the electromagnetic lift forces increase drastically as the magnet approaches the conducting surface. Superconductivity makes possible the large and intense magnetic dipoles required for flight at a reasonable "altitude." These same dipoles also provide a means for propelling the vehicle efficiently by means of a relatively weak travelling magnetic field generated by normal conductors in the guideway.

The Magneplane System, as we have called it, can be described briefly as follows: A cylindrical vehicle equipped with superconducting coils is suspended resiliently by eddy current repulsion one foot



Three common elements are ferromagnetic. A relatively small applied field magnetizes them, but there comes a saturation point beyond which additional field strength is unavailing. (The scale is discontinuous—four orders of magnitude separate iron from weakly ferromagnetic compounds.) Many substances are paramagnetic. While their magnetization does not rise as dramati-

cally as those of ferromagnetic elements, it does not level off as applied field strength increases; it continues to rise linearly. Many industrial processes involving magnetic separation of paramagnetic substances—to purify ore or polluted water—are conceivable if powerful magnetic fields are available, of strengths that can be produced by superconducting magnets.

above a trough-shaped aluminum guideway surrounding the lower third of the vehicle's circumference. The vehicle is free to roll so as to assume the correct bank angle in curves. It is propelled by a travelling magnetic field generated by current loops which form an integral part of the guideway. This field is synchronized by wayside control units on the basis of information transmitted from the vehicle; it reacts against the vehicle coils to provide synchronous acceleration, deceleration or cruise, and also generates vertical and lateral forces to apply active damping to oscillations in the heave, sway, pitch, yaw and roll modes. Lift-to-drag ratio is about 20 at 250 m.p.h., propulsion efficiency is about 80 per cent, and guideway loading is about 2 lb./in<sup>2</sup>. Due to the uniform distribution of vehicle weight and the large suspension clearance, guideway alignment and rigidity are not critical. This makes possible a reasonably priced active guideway. It weighs about as much as conventional rails (100 lb./ft.), requires no additional support structure, and can be laminated continuously from rolls of aluminum and fiberglass, suitably folded and interleaved. The vehicle is carried

on retractable wheels until it reaches about 40 m.p.h.; it can be operated in the open up to 300 m.p.h., and beyond jet aircraft speeds in a partially evacuated tunnel.

The Magneplane System was initially developed with support by M.I.T., Avco, and Raytheon. Current National Science Foundation support will permit the completion of an operating 1/25 scale model in several months. It will hopefully generate the level of support required for a half-scale and ultimately a full-scale system. Sooner or later magneplanes will be the standard mode of travel; whether they are made in Japan, Germany or the U.S.A. remains to be seen.

# Chewing It Up at 200 Tons A Bite: Strip Mining

Time and again, Aubrey J. Wagner, Chairman of the Board of the Tennessee Valley Authority (T.V.A.), has said that concern for the environment must reach beyond streams, forests, and wildlife. His concern is for what he calls the total environment, which includes job opportunities and good school systems as well as blue water, clean air, and green forests. He has said that the availability of economical electric power must go hand in hand with ecological concerns to produce a healthy total environment.

Mr. Wagner has maintained that T.V.A.'s dual role as conservation agency *and* supplier of economic power for development is the same schizophrenia that faces the nation, and that the seemingly conflicting roles must be made compatible.

If we look at the areas where T.V.A. purchases its coal, this total environmental approach is not manifested.

When the Authority awarded the first long-term contract for 23 million tons of stripped coal in Eastern Kentucky in 1962, T.V.A. triggered the modern coal strip-mining boom that is spreading from Appalachia to the Indian lands of New Mexico and Arizona, and throughout the West to

Montana and the Dakotas. The award has since been increased to 34 million tons, approximately what T.V.A. now uses each year. Strip-mined coal represents a significant fraction of T.V.A.'s current purchases. Since T.V.A. is not only a government agency but the largest single purchaser of coal in this country—and ought to lead the thrust for good, conservative mining practices—it serves as a useful example of our larger frustrations.

## The GEM Eats 200 Tons . . .

Strip mining is the stripping away of earth and rock overburden covering a seam of coal, in contrast to conventional deep mining, where the overburden remains in place and the coal is brought to the surface through shafts and tunnels.

The amount of overburden has been the key to the economics of strip mining, since its removal has been the main cost of a stripping operation. Traditionally, a mining operation could profitably move a foot of overburden for every inch of coal. But new technology has advanced the process of strip mining and now many more square miles of land have become appropriate for strip mining. Indeed, Al Funk, Jr., the General Manager of The American Association, Ltd. (a British land company in Tennessee and Kentucky) recently said: "We can move 100 ft. of overburden to get at 30 in. of coal." The U.S. Geological Survey reports that between 1946 and 1970 the average thickness of overburden removed in strip mining for coal has increased from 32 to 55 feet and the maximum thickness from 70 feet in 1955 to 185 in 1970. The average overburden-to-coal ratio has gone from 6:1 in 1946 to 11:1 in 1970.

There are two basic types of strip

mining for coal. Area stripping is done on flat or rolling terrain. Explosives loosen the overburden; then long deep trenches are dug, usually by gigantic shovels like the Hanna Coal Co.'s GEM of Egypt. The GEM has a 200-ton bite and a boom 10 stories high, and its 7,200-volt power plant consumes more electricity each day than nearby St. Clairsville, Ohio—a town of 4,605 people. As trenches are dug one beside another, the overburden from the new trench is supposed to be deposited in the adjacent trench just stripped—the topsoil on top and the acid and mineral strata beneath.

Contour stripping is conducted on the sides of mountains. A road is cut to the area of the coal seam outcrop, explosives are used to loosen the earth and rock, and bulldozers clear away the overburden by pushing it over the side of the mountain. This creates a spoil bank that is nearly impossible to stabilize despite seeding with grass. (Sowing grass is made difficult by the mixture in the spoil bank of top soil, rock, and mineral-bearing strata.) As digging follows the seam into the mountain, the flat area or "bench" gradually widens until the shape of the mountain is significantly changed or the entire mountain top is eaten away.

When it is no longer economical to remove the overburden, the technique shifts from contour stripping to auger mining. Great drills, resembling brace and bit, sometimes eight feet in diameter, are used to bore into the mountain and extract the coal. The auger holes, side by side, close the mountain to more mining because they weaken its structure.

**. . . And There's a Lot of Coal to Eat**  
Strip-mined coal is fast approaching half of the nation's production.

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William Greenburg spent over a year researching and writing a series of articles on strip mining for *The Nashville Tennessean*, and for that series was, with photographer Jack Corn, nominated for the Pulitzer Prize. His efforts also won him threats to life and property that he says are common to those writing about the coalfields. A graduate of Columbia, he has worked for the *Tennessean* since 1965. He concentrates on the social, economic, and political implications of science and technology and on environmental problems. He is currently a journalism fellow at Stanford.

The destructive use of strip mining is blatant in Appalachia, and becoming so in the West. We must decide between cheap coal carelessly procured and more expensive coal that does not cost so much in damage to the land above it.

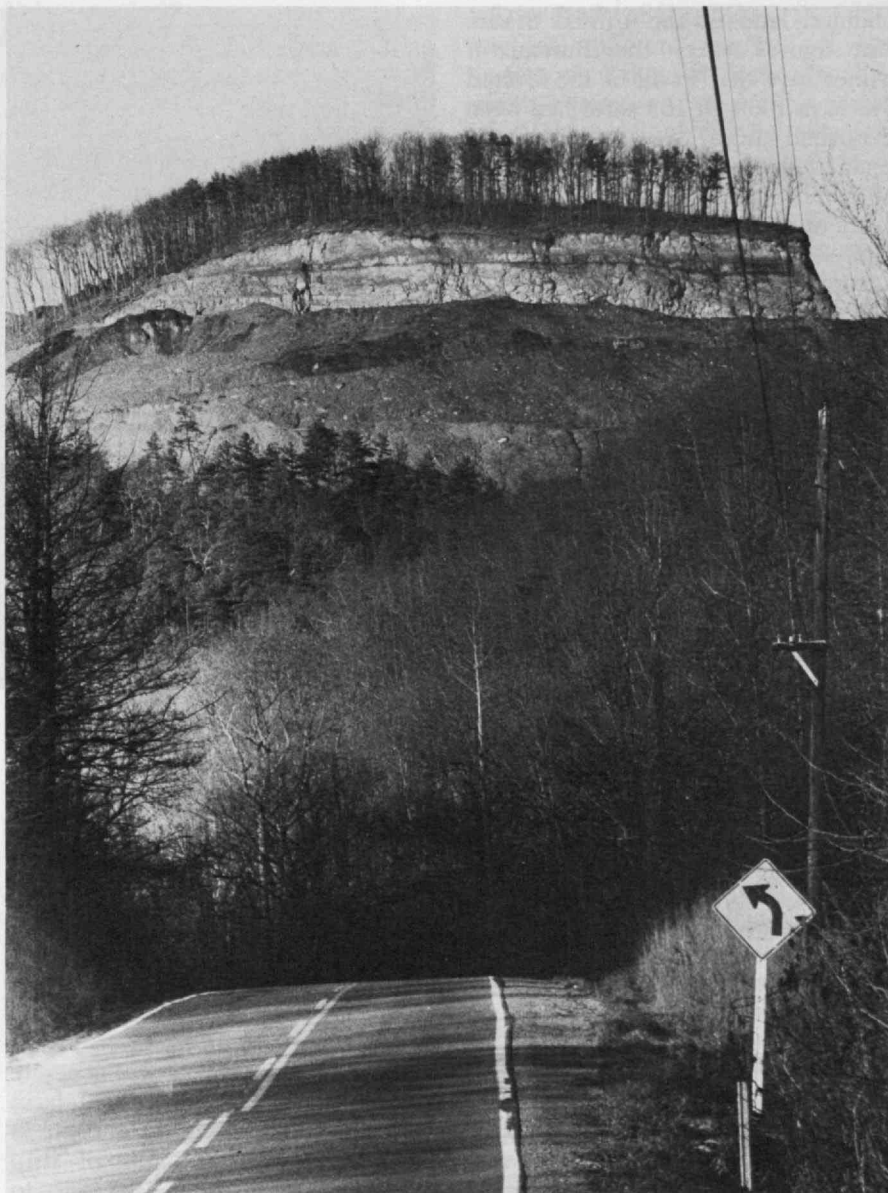
The Interior Department reports that of the nearly 603 million tons of coal mined in the United States in 1970, 244 million were produced by strip mining and 20 million by augering. Most of the coal stripped in 1970—over 147 million tons—came from Appalachia.

The Appalachian Strip Mining Information Service of Seth, W. Va., has found that strippable reserves in West Virginia represent 3.8 per cent of the state's total coal. Twelve per cent of the land would be affected in extracting this coal, including three whole counties—Kanawha, Mingo, and Boone.

But the nation's largest coal reserves—some 70 per cent or more of the total—are to be found in the West, and of 25.5 million tons of coal produced in the West in 1970, 72.4 per cent was strip mined.

In its last complete analysis of strip mining, made in 1963, T.V.A. estimated that 500,000 acres had been strip-mined in Appalachia and predicted that up to 2 million acres of land would ultimately be stripped in the United States. But by 1970, 1.6 million acres had already been stripped in the Eastern United States alone, and Gordon J. F. MacDonald, then a member of the President's Council on Environmental Quality, said in that year that an area the size of Connecticut would be strip-mined in the U.S. in the decade ending in 1980. Rep. Ken Hechler, the anti-strip-mining champion in Congress, believes that coal reserves which may eventually be strip-mined lie under an area equal to Pennsylvania and West Virginia combined.

Nearly all of the land that has been stripped has been left stripped. In 1970, the Interior Department said there were 1,024,000 acres of unre-



The remains of a Tennessee mountain top: you see described the highwall and bench left after coal has been stripped. The road in the foreground is highway 63, named the Howard H. Baker Sr.

Highway, in honor of the late congressman, the father of the present senator whose home is only a few miles from this mountain. Commented Senator Baker on the view: "Ugh."

claimed land in the United States. But figures vary: the Bureau of Mines says that in all of the United States in 1969, 67,163 acres had been disturbed and 57,898 acres had been reclaimed. T.V.A. claims that by 1970 more than half of the 1,600,000 acres of stripped land in the Eastern United States had been reclaimed according to "present state laws."

### The Economics of Strip Mining

The main reason for the growth of strip mining in the U.S. is economic: extracting coal by this method is cheaper than deep mining.

In 1968, the Bureau of Mines reported that the average number of men working daily in strip and auger mining was 24,954. The strip miners produced 34.24 tons of coal per day per man, and the auger mines produced 40.46 tons per man per day. In that year, the 102,940 deep miners produced 15.40 tons per day per man.

The Bureau reported that the cost of underground coal (at the mine) was \$5.22 a ton in 1968 and \$5.62 in 1969. Stripped coal cost \$3.75 a ton in 1968 and \$3.98 in 1969.

The price T.V.A. pays for coal has increased steadily from \$2.69 a ton in 1929. The average cost is still rising: one ton of coal—both strip and deep—delivered to power plants in 1968 cost \$4.17; \$4.35 in 1969; \$4.50 in 1970; and \$5.90 in 1971. The long-term contracts T.V.A. awarded in the spring of 1971 ranged between \$7.50 and \$8.50 a ton.

Most of the coal in the nation is used in electric power generation; therefore, the cost per B.t.u., not the cost per ton, is the significant one. This figure brings into the cost compilation at least one aspect of coal quality. The number of B.t.u.'s per pound of coal has dropped steadily



An aerial view of stripping on mountainside in eastern Tennessee, this photograph shows many mudslides from bench to bench. Stripping a slope disrupts the normal channels that carry water rain down the slope; if the stripper

does not make channels for it and if he does not carefully pile and replace the overburden, rain—or the sheer bulk of the mud—will cause mudslides that can be disastrous.

during recent years, as an increasing proportion of U.S. coal has been taken from strip mines: from about 12,000 in 1951 to 11,356 in 1969 and to 10,796 in 1971. The price T.V.A. paid for enough coal to generate one million B.t.u.'s increased from 16.50 cents in 1946 to 20.02 cents in 1952. With the economies of strip mining, it went down in 1965 to 17.06 cents. The price went up again to 20.25 cents in 1970 and to 27.23 cents in 1971.

Balanced land use or resource development policies have never been adopted in the coal fields. They have been ignored so that coal could be purchased at the cheapest price.

T.V.A. is required by law to purchase coal as cheaply as possible, and it has not chosen to admit that such an approach is really a false economy that results, when strip mining is involved, in damage beyond repair and in social costs beyond calculation. Rather, T.V.A. defends strip mining and attempts to cover its tracks with reclamation programs that have not worked.

Mr. Wagner has said that reliance on coal as a basis for development in Appalachia is a mistake, and that a systems approach should be taken to nurture diversified development on a regional basis. But a recent policy statement from T.V.A. on coal pur-



This is the road leading up to a strip mining site in Tennessee that a federal injunction closed over a year ago for violating the 1899 refuse law. There has been no attempt to reclaim the land,

Mr. Greenburg reports, although the company did post a \$10,000 bond to ensure that activity. Given the condition of this land, he adds, that won't buy much reclamation.

chasing takes another stance: "It has been said that strip mining has caused outmigration from the Appalachian region, that it has discouraged tourism and that it is responsible, at least partially, for the depressed economic conditions that exist in that part of the country. The causes of the Appalachian economic situation are complex, and the situation has a very real impact on the human environment of the region. But the plight of Appalachia, in T.V.A.'s view, has not been caused by strip mining, nor does strip mining generally contribute to it. In many cases mining (strip and underground) is the only major industry

in a county."

Studies and statistics about the effects of strip mining on the environment and economy of an area are now emerging, and they contradict T.V.A.'s belief. Indeed, T.V.A.'s own attempt to show that strip mining is beneficial economically to Appalachian counties backfired. The study analyzed strip mining's effects on two selected groups of counties in Eastern Kentucky and Eastern Tennessee. The counties were similar but one group sustained strip mining, the other did not. Although it was a heavy industry in the former, there was no difference in individual income as a result.

### A Case Study of One Mine

Another, different analysis of the business is a detailed look at a strip mining operation called "The Myles Job Mine—A Study of Benefits and Costs of Surface Mining for Coal in Northern West Virginia," written in 1968 by Samuel M. Brock of West Virginia University and David B. Brooks of the Bureau of Mines.

The firm involved was a leading strip miner of medium size in northern West Virginia. It is important to note that this study involved only one type of terrain: 11.6 acres of an abandoned 41-acre farm in a valley that sloped up hill-sides with grades of 25 to 40 per cent. There were two seams of coal, 44 and 40 inches thick; the mine dug into the side of a hill and left a high wall about 80 ft. in height.

"The successful operation of the firm is in large measure due to the skill of its management," the study reported. "Part of any profit the firm earns is a return to this expertise, which may be scarce in the surface mining industry."

The study recognized this point early. The industry environment, one of little or no regulation and almost no taxation, has spawned a breed of operator who, although quick to raise the banner of free enterprise, could not survive in a free market.

It was estimated that 47,610 tons of coal would be recovered from the Myles job. The projected revenue based on \$3.85 a ton before delivery was \$183,298. During the mine's operation, the laws controlling strip mining in West Virginia changed, the new 1967 law placing stricter requirements on reclamation than the 1963 law had. The study figured the mine's operating costs according to both laws. The cost of grading

changed from \$585 to \$845 per acre; that of revegetating from \$406 to \$791. The new law required a different sort of planning, however, which saved the company several hundreds of dollars in engineering costs, so the net profits to result from each scheme were not too different: \$51,195 under the 1963 law, and \$50,591 under the 1967 law. In the Myles job, the strip mine operator made more profits than the owners of both the mineral or surface rights. Each of the latter was paid royalties of 20 cents a ton for a net revenue of \$8,456 each. But the net revenue to the holder of the mineral rights, if his costs in holding them for 43 years are subtracted, was only \$320.

Such studies must also be made of operations on different terrains with varying coal deposits, to learn generally what conditions—physical and managerial—permit the profits to pay for reclamation.

#### **The Economies of the States and Counties**

Another recent study took a look at what the West Virginia economy might be like between 1971 and 1975 if strip mining were banned in the state. The paper was delivered the November, 1971, to the Southern Economic Association and the Southern Regional Science Association by William H. Miernyk of the Regional Research Institute of West Virginia University.

Dr. Miernyk observed that the abolition of strip mining in West Virginia would result in a small increase in overall employment, a large increase in capital investment, and no net change in the level of trade. The study assumes that overall coal production—now all from underground mines—in the state would continue as though no change

had taken place.

He calculated that there would be some loss of employment in the coal mining industry if stripping were abolished. There would also be job losses in the trades and services, in finance, insurance, real estate, railroads, and non-electric utilities. These decreases would be offset by gains in construction, manufacturing, and electric utilities. Dr. Miernyk said that there would be a net increase of 558 jobs in a West Virginia which produced only deep-mined coal in 1975.

His observation that coal miners would lose jobs if stripping were abolished presents an interesting twist. There would be, he said, a 3.5 per cent drop in employment, and he reasoned that even though 2,086 deep miners would be needed to produce the strip mines' share of the coal, 2,787 deep miners who now supply coal to the strip mine industry would be eliminated. (Some deep-mined coal is mixed with strip-mined coal to improve the latter's quality.)

#### **Much Taken: Little Given**

Tax records in Tennessee offer still another view of the economic effects of stripping. It becomes obvious that the strip miners ship wealth out of at least this state and they return very little in taxes. The Tennessee Land & Mining Co., for example, paid \$12,107 in property taxes in 1970 on its Anderson County holdings of 21,324 acres. On its 34,041 acres in the same county, The Coal Creek Combine paid \$21,926 in 1970. The Payne-Baker Estate paid \$18,941 on 39,000 acres in Scott County, Tenn.; the Blue Diamond Co. paid \$12,989 on 19,000 acres. In Morgan County in 1970, The Ford, Faust and Cheely Land

Co. paid \$761 on four tracts totaling 1,015 acres.

In Campbell County an attempt was made to have the appraisal reflect the mineral wealth of the land. The worth of the Tennessee Land & Mining Co.'s holdings were listed on the appraisal card at \$785,870, and the Lindsay Land Co.'s holdings of 5,358 acres were valued at \$230,000. These figures were crossed out; \$449,000 was written in for T. L. & M. and \$112,650 for Lindsay Land. Tax assessor J. P. Ayers said that the appeals were made before he took office and that the State Board of Equalization had lowered the appraisals.

In only one county, rural Sequatchie in the state's southeast coalfield near Chattanooga, was the tax assessor partially successful in getting more revenue for his county through increased appraisals that reflected mineral wealth. This fight pitted assessor Ivan Condra against The Tennessee Consolidated Coal Co. and the U.S. Steel Co. Mr. Condra tried to get an increase in value of \$300 an acre on the coal lands. He succeeded in getting an increase of \$180.

But even this success has helped Mr. Condra but little with his appraisals of strip-mined land.

"The strippers just move along with their drills and where they find coal, they start stripping," Mr. Condra told me in August, 1971. "We must assess a year in advance and we have no way of knowing that coal is present if not included in available studies. When the strippers come in, you know that it is there, and all you can do is sit and watch the trucks roll by, loaded with coal."

The coal industry also leaves in its wake tremendous damage that adds financial burdens to already hard pressed counties.

Overweight coal trucks tear up roads, for example. The counties cannot afford to repair them, nor, usually, can the state. The Tennessee gross weight law sets a limit for truck and load of 73,280 lbs. The scales at the T.V.A. Kingston Steam Plant showed trucks coming in weighing 82,000, 81,750, and 83,250 lb. Other records show trucks weighing 97,600, 99,500, and 92,600 lb. Rarely does a truck come in under the limit.

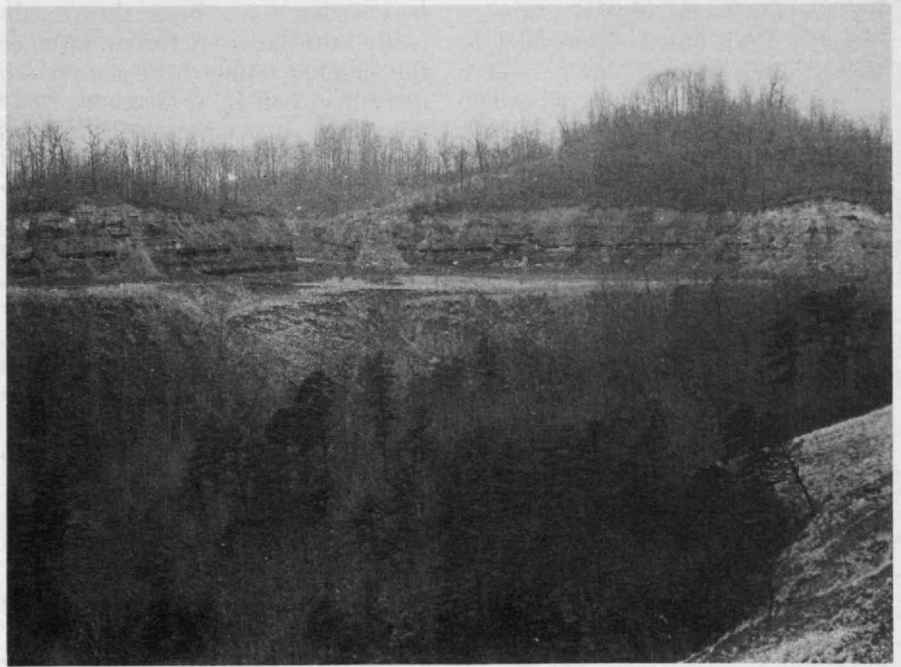
The counties and state also pay to clean roads inundated by mudslides that result from stripping. By April 1971, Anderson County engineer Gordon E. Colbern told me, the county had spent \$17,000 cleaning off one small section of the Frost Bottom Road following the closing of a strip operation 16 months before.

The financial drain was evident when James Bunch, principal of the elementary school in Petros, in Morgan County, Tenn., told a public tax hearing in Nashville in late 1971 that the county school children could not compete with others in college admissions because the county school system could not afford to prepare them properly. His school was built in 1927, and although it is in the heart of the coal region, the pupils must wear their coats in the cafeteria in the winter.

A severance tax is emerging as a state-wide issue.

### What Kind of Damage is Done?

The destruction of landscape and land that is associated with strip mining does not escape even the least trained eye, and it is through this problem that strip mining has become a national issue. What are the environmental effects, and can they be mitigated?



In the chasm is Lots Creek, which was stripped for the Tennessee Valley Authority over ten years ago. There has

been no salvaging of the land: the mine itself is still barren, the mud slide towards the creek not cleaned up.

The most famous study concerning environmental effects of strip mining was conducted between 1955 and 1966 in the Beaver Creek basin of Kentucky by federal and state agencies and the University of Kentucky. Here is a summary of the results: Strip mining in the Beaver Creek basin significantly increased the sediment of streams below the mined area. A stream in the mined area carried 12 times the load of dissolved solids of a nearby stream not affected by mining: between 1957 and 1962 the Cane Branch transported about 1,370 tons of dissolved solids per square mile of drainage area, the nearby Helton Branch only

111. Sediment concentrations in Cane Branch commonly exceeded 30,000 p.p.m. during storms; the maximum in Helton Branch was 553 p.p.m. During the four years after strip mining had ceased, the annual sediment released into streams from areas not stripped averaged about 25 tons per square mile; that released into Cane Branch averaged 1,900 tons. The average sediment yield from the spoil banks was about 27,000 tons per square mile—more than 1,000 times greater than from the undisturbed areas.

Sedimentation is the chief problem below all strip-mined areas. In July, 1971, the U.S. Soil Conservation Ser-

vice reported on the 41,000-acre Crooked Fork Creek Watershed in Morgan County, Tenn., where "stream channels have become clogged with debris (sediment) washed down the steep slopes from the strip-mined areas. The primary problems in Crooked Fork Creek Watershed are flooding in the town of Petros and destruction of crops and pasture on the bottom land downstream from Petros."

The state spent \$25,000 to clear about eight miles of Crooked Fork Creek in 1957 and 1958. But, says the report, "The channel has gradually filled over the years and has become clogged again. The upper four miles has lost more than half of its size since the completion of improvements in 1958."

An important problem the Beaver Creek and Crooked Fork Creek studies did not consider is the effect of strip mining on large watersheds. S. Leary Jones, Director of the Division of Water Quality for the Tennessee Department of Public Health, has said that the effect of strip mining on large watersheds must be thoroughly explored; "we know the damage is there," he insists. The State of Kentucky will embark on such a study.

William J. Baxley, attorney general of Alabama, has said that throughout the length of the Black Warrior River from Birmingham to Tuscaloosa, sediment damage is extensive and obvious: "Fish habitats have been destroyed, bridges and roadways eroded, culverts clogged, and the stream banks undercut. In several instances the useful life of flood control and water storage projects has been cut in half along this river. Strip miners have frequently mined so close to the Warrior River that large amounts of coal spoil and

overburden have been thrown directly into the river. In one instance this practice reduced the river width more than half for a distance of one mile. Piles of overburden as high as 80 feet have been placed squarely at the river's edge, waiting for heavy rains to wash them into the river."

Other environmental problems are also cited as effects of strip mining. Although acid mine drainage is usually associated with deep mining, stripping can trigger acid run-off either directly from acid spoil or by opening abandoned deep mines.

Dan Sherry, stream biologist with the Tennessee Game and Fish Commission, pointed out to me that pH readings of 4 to 5 in the Jones Branch of the Obed River were connected with strip mining and the operation was stopped.

"We estimated that in 1967 235 miles of streams were ruined by both deep and open pit mining in Tennessee," Mr. Sherry added. "This has to be conservative because it has been estimated that in the Obed River basin alone [a different river], 235 miles of water ways have been ruined by coal mining. The New River has been wiped out. This was a very important scenic river. We only have a few good quality streams left in East Tennessee. We want to save these high quality water ways."

#### **Repairing the Devastation: Expensive . . .**

Reclamation of strip-mined land is simple enough in concept: after the coal is gone, bring the overburden back into its original position—first the rock, then the topsoil. But in fact reclaiming the land and estimating the costs of doing so are equally chancey propositions.

R. W. Hatch, president of Hanna

Coal Co. which operates in the relatively flat areas of Ohio, said in testimony before a Senate hearing on strip mining in November, 1971, that his company's records show that over the years reclamation costs have averaged about \$460 an acre. Some areas, he said, cost \$200 an acre to reclaim; some cost \$1,800 an acre. He said he knew of a job—in which the soil was put back in the proper order—that cost \$5,000 an acre. This approaches the estimates for the largest showcase reclamation in the world—in West Germany—which cost about \$6,000 an acre on flat terrain. Mr. Hatch also said he knew of a job in Pennsylvania that cost \$11,000 an acre to reclaim. William Guckert, Pennsylvania's chief strip mine reclamation officer, quotes costs between \$70 and \$250 an acre.

Some of these figures represent exceptional showpiece projects like parks. Most of the references were to flat areas.

A Sierra Club study of reclamation in Great Britain, where strip-mining regulations are very strict and where operations are confined to area-type stripping, shows costs that range between \$1,350 and \$7,542 an acre.

Over the years, T.V.A. has changed its estimates of reclamation costs. In 1963, it said that the average cost was \$50 an acre: \$70 an acre in relatively flat southern Illinois and \$45 an acre in the mountainous portions of Virginia. (But the report said that the cost might jump to \$250 an acre or even to \$1,000 in some areas.) Based on a 3-ft. seam and 5,000 tons of coal per acre, the average cost of reclamation was one cent a ton. The Authority's newest reclamation cost figures are \$500 an acre for flat lands and \$200 an acre for mountain lands.

The general wisdom, curiously, would transpose those figures, believing it easier to re-order land that is flat. Charles Gouffon, a member of T.V.A.'s upland wildlife division, and one of the authority's top reclamation officers, explains that the \$500 represents the more costly procedure of filling up the trenches which sometimes are 150 feet deep. The question remains: what does the \$200 pay for on a forbidding mountain side?

No one, in fact, really knows how much it costs to reclaim land on a steep slope, or even if it can be done. Leading representatives of the strip mining industry have acknowledged that Tennessee coal is just not competitive and could not bear the brunt of expensive reclamation. T.V.A. has in force a policy not to award stripping contracts on slopes greater than 28 degrees, but it began a pilot project in the spring of 1972 to determine the cost of the "ultimate" in reclamation on a steep slope.

Are there successful examples of mountain reclamation? Yes. And the industry is quick to point to them. In every instance, however, these reclamation projects represent an investment which turned the land to a different use than it bore before it was stripped.

One such place is the Lonesome Pine Airport in Wise County, Virginia. This airport was constructed on a strip mine site which flattened the top of a mountain, reclamation involved leveling the remaining knob. The excavation cost was \$480,000. The entire cost of the airport was \$840,000, including the land purchase of \$29,000. The Federal Aviation Agency contributed \$420,000, the Appalachian Regional Commission contributed \$210,000,



What strip miners did to one family's neighborhood in Campbell County, Tennessee. The pile of rocks and boulders behind the home is an unstable spoil

bank—the pile of overburden stripped off a seam of coal and—obviously—not replaced.

the state contributed \$190,000 and local government gave \$20,000.

Another piece of reclamation that the industry refers to with pride is in the same community. The Norton Elementary School which opened in 1971 was built on a strip-mine site. The 27-acre project cost \$219,000—\$8,100 an acre. The Appalachian Regional Commission paid \$164,325 and the state paid \$54,775.

A third lies in Jellico, a small town

on the Tennessee-Kentucky state line on Interstate 75. It is tucked in the heart of mountainous strip-mining region. At an old strip-mining site on rolling terrain, almost in the town, a park is almost completed. The objective was just to revegetate so the land will blend into its surroundings. No exceptional work was done to enhance the reclaimed land to a state better than its original condition. The cost for the 300 acres

is \$325,000—a bit more than \$1,000 an acre—all paid by the federal government through the Appalachian Regional Commission, which bore 75 per cent of the expenses, and by the State of Tennessee, which paid the other 25 per cent.

#### .... If It Works

But generally, reclamation has been a failure: where no enhanced use of the land is anticipated which would be worth the investment, reclamation is almost nonexistent.

The major problems in mountain stripping in Appalachia are where to put the overburden and how to control or confine the water that is diverted from its normal channels. Up to now the overburden has been thrown over the side and the water has rushed down the mountainsides, the two activities creating landslides, filling stream beds, and causing floods.

After a haul road is cut into the mountain some operators and state agencies believe it is a good idea to scalp the slope directly below the mining operation of all vegetation. The theory is that overburden deposited on the side of the hill will adhere better. There is just as much doubt that scalping is a good procedure as there is belief to support it.

Ideally, the spoil ought to be separated into topsoil, rock, and mineral-bearing strata, but this appears to be impossible once the explosive charges are set. So it is now being recommended that, after the first cut is made into the mountain, all the spoil material be retained on the strip-mine bench and graded as mining progresses. While this process is going on, water control measures, such as building drainage ditches along the bench and drainways down the mountain, are to be taken.

There is also support for building drainage ditches above the strip mines to divert water from the operation, and for establishing silt traps and dams below the stripping operation, which will confine sediment while allowing water coming off the mountain to flow into streams, silt free. Planting with grasses to stabilize the area should follow stripping and grading as quickly as possible. This in turn should be followed by the planting of more permanent types of growths, such as trees, during the first growing season after the land has been disturbed.

When the stripping is completed, the coal seam is covered and a ditch is formed around the mountain. This ditch may be used as a drainway. A highwall remains, a sheer cliff that forms a right angle with the bench that has been cut out of the mountain. Some people urge that instead of leaving a ditch, the bench be graded toward the highwall to create a slope roughly like the original slope of the mountain. The highwall might also be reduced considerably or entirely by a combination of grading toward the highwall and blasting away its upper fraction. There is a great deal of opposition to this, mainly from environmentalists who maintain that this just creates another unstable slope and causes more damage in the process.

The general procedure of grading to approximate the original slope has not been very successful. The degree of success depends on the degree of slope, the watershed, and the composition of the earth.

On flat or rolling type terrain, the reclamation concept is quite simple. The earth covering the coal seam is scooped up, its different layers deposited in different piles. When the

coal is taken out the earth is put back in its proper order, graded, and planted. During the operation diversions and drainways are constructed for water. Even this process depends on the composition of the earth covering the coal and on whether blasting must be done. With the finding of coal seams up to 200 feet thick, particularly in Montana, has come the question of how such a cavity is to be filled so that the land can be shaped to blend into the surrounding area.

One of the overriding factors in reclamation is whether the land is worth the expense of meticulously separating the earth and putting it back in order. If there is no financially beneficial use such as farming or grazing, it is questionable whether operators want to spend the money for this type of reclamation. The successful attempts at even simple revegetation are scarce and disheartening. Revegetation usually produces a pine culture in place of a native mix with a healthy amount of valuable hard woods. (These hardwoods are too often wantonly destroyed by strip-mine bulldozers.)

"Quite frankly I've never really seen any good reclamation," Senator Howard Baker (R.-Tenn.) who sponsored a strong control bill for strip mining, told me in 1971. He had ended stripping on his family's 40,000-acre estate in Tennessee.

"There used to be a lot of hardwoods in this country, but now you may be able to find a pine twig or two in those strip-mined areas," said 68-year-old Joe Angel of Jellico.

"I've seen some of their so-called reclamation and a mountain goat couldn't even stand on it," said Paul King, a deep miner from the White Oak Community. "They throw out some grass seed and every time it

rains you can see some green. When the sun comes out it dies."

### Can the Human Damage Be Repaired?

Sen. Baker, Mr. Angel, and Mr. King tell at first hand what strip mining does to the land. The effects on people too are considerable and poignant.

In 1961 Mrs. Lige Ritchie of Knott County, Ky., watched a strip-mine operator's bulldozers push the graves of an infant daughter and infant niece over a hillside. She saw the caskets go over, buried forever in an unknown place.

Mrs. Fronia Duncan, a Fentress County, Tenn., widow, has had her well water ruined by strip-mine blasting and she does not know where to turn for help.

Ralph Massengill of Morgan County, Tenn., saw his nearly two-acre vegetable patch and his hog pens turn into a mired spoil bank with his crops and stock destroyed, when Crooked Fork Creek went on a rampage, its bed choked with sediment from strip mines in the area.

And a Tennessee mountain man told me "that in the winter my father and I would scrape bark off of trees to make charcoal to heat the house. The American Association man came along and told us the land was worthless and that for \$1 an acre we could live on the land and not have to pay taxes [the people do pay rent]. My father and a lot of others sold, and we didn't know it but we were standing next to 4 feet of coal."

Like many other giant land owners, The American Association, when title was in question, would sometimes convey a parcel of property to a public body on a quitclaim deed. In one case, for example, stipulation

was made that property deeded to a county school board would have a school built on it within a year. After the year and no school, the board conveyed the property back to The American Association under clear title which is a warranty deed. Once this is done the public body has the responsibility of defending the old quitclaim against any heirs that might show up.

The American Association has done its best to encourage the people to move. The people in the tiny hamlet of Fonde, Ky., on the Tennessee state line in a remote area, had to get a federal grant for a pump for the town water supply. The American Association owns Fonde.

Damage to the people of Appalachia, damage to the environment, and the inhibition of economic development will continue.

The Tennessee strip mine law of 1967 is unenforceable, and coal industry leaders have acknowledged that the industry drew up the legislation. And if the efforts to achieve strict legislative reform do not succeed, there is nothing the people can do to protect their rights.

"I saw the sheriff about the stripper's blasting," said Larry Bradley of Jamestown. "He told us that to get an injunction we would have to put up a bond. We can't afford that."

"I want to see if there is any law in this county," said Byrd Duncan of Anderson County, complaining of the blasting. "Where is the law?"

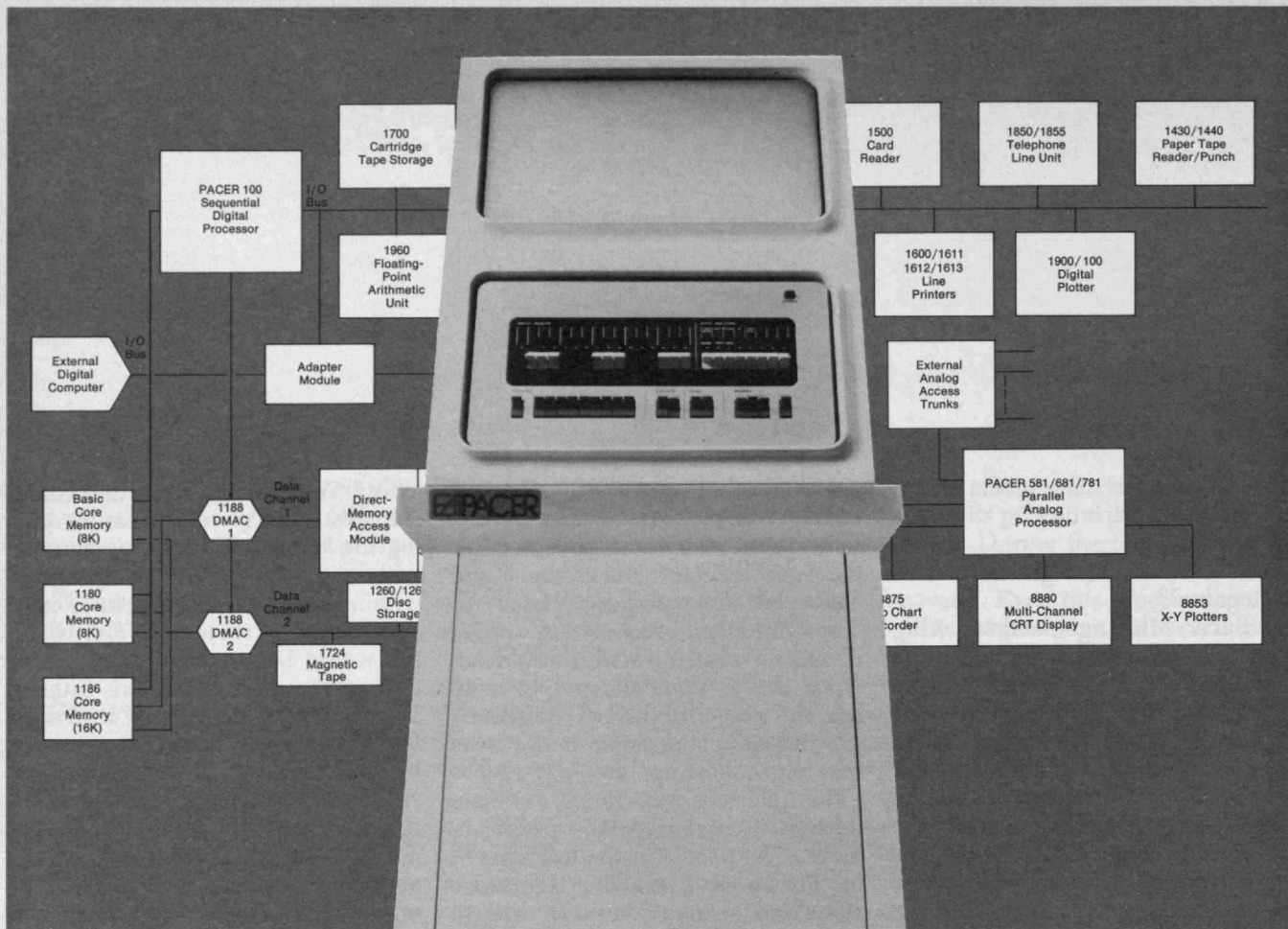
If the law is elusive to the people of Appalachia so are the lawyers: most who practice in the coal regions earn their livings from the coal industry.

As for laws controlling strip mining on the federal level, there were in October, 1971, about 20 bills in Congress. They ranged from the all-out ban sponsored by Rep. Ken Hech-

ler of West Virginia to the Nixon Administration's weak measure giving the states two years to come up with a workable control program within broad federal guidelines or to accept federal standards. The Nixon bill would have put the administration of the program in the Interior Department, which foes of strip mining consider to be an instrument of the coal industry. The toughest measure short of banning, introduced by Sen. Baker, would have put enforcement in the hands of the Environmental Protection Agency; it was so written that it would put an end to strip mining in the mountainous regions of Appalachia. The bill that got through the Senate Interior Committee (whose chairman, Wayne Aspinall, a Democrat from Colorado, was not re-elected this year) was very weak, but even it was killed in October. A tougher bill is expected to run the gauntlet through the next Congress.

If strip mining is banned, coal will have to be mined by underground methods. This means that attention must be given to the environmental problems of deep mining—mining that must now be conducted, with full regard for the health and safety of the miners. The price of coal will probably increase, reflecting the cost of high-quality reclamation where it is deemed feasible, and the increase must pay for the health and safety of the miners and the environment as well.

Coal is a valuable resource and the need for it will continue. But, forests, streams, education systems, roads, and job opportunities are valuable resources also. To harvest coal at the cost of destroying other resources is foolhardy. It will prove expensive beyond all means in the long run.



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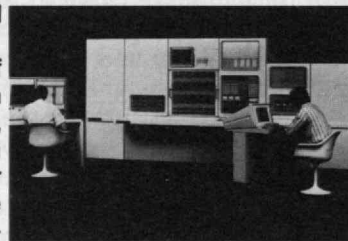
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## Trends This Month

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## ENERGY

### Is There an Energy Crisis? Many Views

The "energy crisis" was visited upon New York twice during the last week in November. Not that the lights went out in Manhattan or that the taxis ran out of fuel; indeed, only by looking at the programs for the annual meetings of the American Society of Mechanical Engineers and the American Institute of Chemical Engineers could one make a case for "crisis" by either dictionary definition ("the decisive moment, turning point"; or "that change in a disease which indicates whether the result is to be recovery or death") as more than 5,000 engineers gathered in artificially lighted, overheated ballrooms.

Clearly it is a time of changing attitudes about energy and hence in technological priorities. But one's judgment of what may be considered "a decisive moment" in this energy-intensive economy depended upon to whom he listened, and that in turn depended significantly upon the speaker's affiliations and which data out of a rapidly increasing library of statistics he chose to use.

But almost all would have agreed with Hoyt C. Hottel, Emeritus Professor of Chemical Engineering at M.I.T., when he told his A.I.Ch.E. colleagues on November 26 that:

□ The U.S. is not basically running out of fuel. It is simply that a continuation of past trends in energy consumption will create "an impossible situation" in 200 years—and perhaps sooner.

□ Considering the basic human needs of millions of people in underdeveloped countries and even in underprivileged segments of our own nation, an increase in energy consumption for at least the next 20 years "must be regarded as a good thing."

□ Present and future energy requirements simply cannot be met from sources other than fossil or nuclear

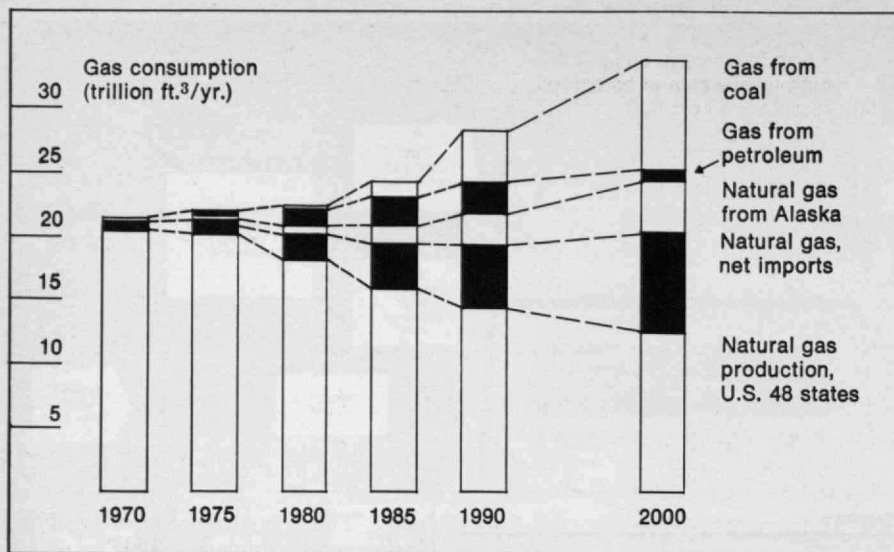
fuels. "There is an enormous need for fundamental understanding" which might increase the efficiency and speed the time in which fossil and nuclear fuels can be used more efficiently and safely. This is "the greatest challenge before us," he said, and we need not be led astray by wishful thinking that geothermal, hydro, or solar sources can make significant contributions to meeting our future energy needs.—J.M.

### Many Routes to Gas

Is the energy crisis real? It is if your desk is burdened by letters from public utilities whose supplies of natural gas are suddenly curtailed, said Rush Moody, Jr., Federal Power Commissioner, with feeling (*see above*). Or if you are the Senior Vice President of Gulf States Utilities Co., an administrator of the Southwest Power Pool, half of whose 27,000 Mw. of generating capacity designed to burn gas must be converted to oil because gas—basically a nonpolluting fuel—is not available. To convert a boiler from gas to heavy oil costs \$20 to \$40 per kw., S. L. Adams, Senior Vice President of the Gulf States Utilities Co. told the A.S.M.E. What will then happen to the price of low-sulfur oil? he asked.

Mr. Adams' frustration is not lessened by learning that there are presumed still to be substantial undiscovered natural gas resources in the U.S. But they will not be found, said Gerard C. Gambs, Vice President of Ford, Bacon and Davis, Inc., until gas prices are established by those who regulate them at levels high enough to support investment in exploration.

Are there other routes to gas? There are, indeed. The technology for making clean, low-sulfur gas from coal is largely available—but far from ready for use. In their review for the A.S.M.E., Howard M. Siegel and T. Kalina of Esso's Synthetic Fuels Engineering Division proposed "extensive development work" to result in plants first operative from 1977 to 1984. S. H.



If there is a U.S. energy "crisis" today—or if there will be one tomorrow—it most obviously affects those who depend on natural gas. These projections, presented last fall at the annual meeting of the American Institute of Chemical Engineers by Henry R. Linden, Director of the Institute of Gas Technology at

Illinois Institute of Technology, show how the U.S. will be increasingly dependent on imported gas in the years ending the 20th century—and how important will be the technology of coal gasification, several processes for which are only now approaching the pilot plant stage.

Schurr, of Resources for the Future, Inc., agreed—but warned the A.I.Ch.E. that even under the most optimistic schedules not more than 2½ per cent of the nation's energy requirement in 1985 could be met by "clean" gas fuel made from coal. Arthur M. Squires, Head of the Department of Chemical Engineering at City University of New York told the A.I.Ch.E. that he sees existing plans to make gas as "the most significant changes affecting coal or oil utilization that are now in view for the 1970s" and he and his colleagues "confidently expect several thousand megawatts of power gas capacity by the early 1980s, at least some of it based upon coal." (See "Capturing Sulfur During Combustion" by Arthur M. Squires in the December, 1971, Technology Review) For the A.I.Ch.E., Prof. Squires described a "coalplex" energy enterprise in which coal could be converted into hydrogen-rich "clean" fuels such as a methane and benzene to be transported for distant use and a gaseous residue with relatively low heat content to be transformed on the site into electricity. Research on a first-generation "coalplex" is proceeding and a preliminary flow-sheet suggests that more than 96 per cent of the energy-value of the input coal might be represented in the electricity, sulfur, and enriched fuels.

Still another route to gas was proposed by Thomas R. Schneider of the Public Service Gas and Electric Co., reporting work done at the University of Pennsylvania's National Center for Energy Management and Power: organic

wastes or specially grown plant material, converted to methane by anaerobic fermentation, the same process of decomposition practiced at many sewage treatment plants. According to Dr. Schneider's calculations, an amount equal to current U.S. annual gas consumption of  $2.2 \times 10^{13}$  ft.<sup>3</sup> might result from decomposing  $2 \times 10^9$  tons of dry organic material; already the U.S. annually accumulates between 25 and 40 per cent of that amount as organic wastes. With gas prices at \$1 per 1,000 ft.<sup>3</sup>, the feedstock would have to enter the process at less than \$10 per ton—which Mr. Schneider admitted to the A.S.M.E. "is a serious economic constraint."—J.M.

## Politics and Oil

What of oil, the "swing" fuel that comes to our rescue when gas runs low and environmental requirements prohibit use of coal? It was here that unanimity seemed most elusive and inconsistencies most obvious. S. H. Schurr, of Resources for the Future, Inc., insisted to the A.I.Ch.E. (see above) that domestic petroleum reserves are predictable and known reserves are very large: 1,500 trillion ft.<sup>3</sup> of gas and 200 billion barrels of oil, respectively 60 and 30 times current annual production. The changes are "good and improving" of realizing these reserves despite their location offshore and in other hostile environments, and Mr. Schurr argued that a 20 per cent increase in domestic oil

prices now would stimulate a 60 per cent increase in domestic production by 1985.

Rush Moody, Jr., Federal Power Commissioner, took a similar position for the A.S.M.E. "There is enough natural gas left in the ground to see this country through the 30 to 50 years. . . . I do not see how we can afford to pass up the potential producing capacity remaining in this country."

He asked for action to insure development of our domestic resource base . . . for expanded [production], . . . for realistic oil and gas pricing, . . . for responsible regulation which recognizes that the first obligation of consumer protection is development of reliable and adequate service at the lowest reasonable cost . . .

How much of this is politics, how much technology? Few engineers were so optimistic about domestic supplies or so willing to commit them to immediate exploration and use. Indeed, Hoyt C. Hottel, Emeritus Professor of Chemical Engineering at M.I.T., offered the much more typical prediction that U.S. petroleum supplies will be substantially short of demand by 1985—perhaps by as much as 16 million barrels of oil a day. To fill that need would take a fleet of 150 large super-tankers arriving so frequently that one would be emptied on our shores every two hours. That would represent "a scale of fuel importing unprecedented in the world," Professor Hottel said—and a similarly unprecedented balance of payments problem for the U.S.

An unrealistic scenario? Perhaps, since it is based on extrapolations of the recent past. But W. J. Coppoc, Vice President of Texaco, Inc., in charge of its Environmental Protection Department, noted for the A.I.Ch.E. that environmental control programs will have the effect of increasing, not decreasing, petroleum demand. In 1971 the National Petroleum Council predicted U.S. demand of 26 million barrels a day by 1985; Dr. Coppoc thinks that figure might be reached instead in 1982.

At another stage of the A.S.M.E. meeting, W. B. Behnke, Jr., Vice President of Commonwealth Edison Co., made the same observation more seriously: Increasing costs of environmental requirements can only mean price increases, he said, and resistance to these may lead to "an artificial energy crisis—which is not really a fuel crisis but a regulatory crisis—one aggravated by the squeeze between regulated price ceilings and high-cost requirements."—J.M.

## For the Future: Nuclear Power

Nuclear sources now provide 5 per

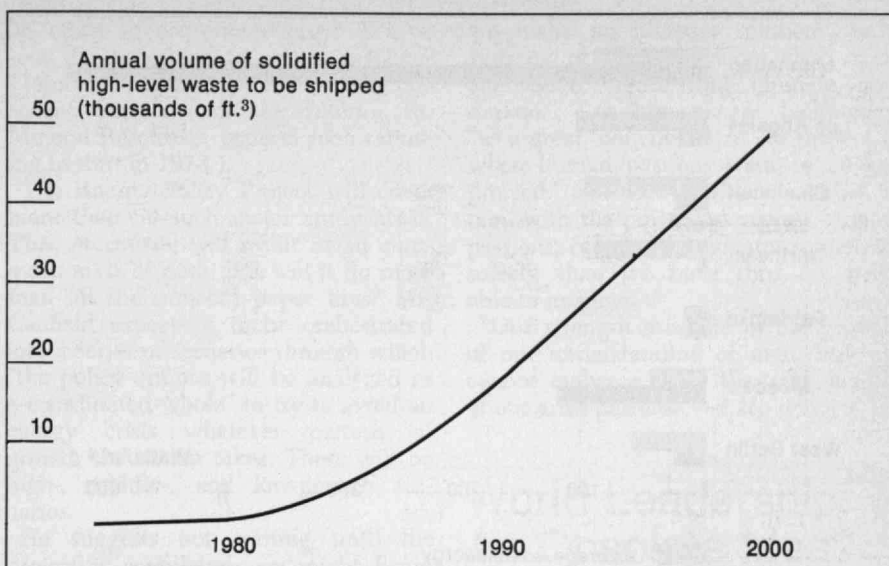
cent of total U.S. energy requirements; that will grow to 12½ per cent by 1980 and 24 per cent by 1985, according to official forecasts. But Elmer F. Bennett, Assistant Director of the Office of Emergency Preparedness, told the A.S.M.E. (see above) that "serious slippages may well occur in these estimates." He was thinking of financial, engineering, and environmental constraints—and recognizing that nuclear capacity has developed more slowly than originally hoped by many proponents.

No reservations came from engineers discussing nuclear fission and breeder reactors on the programs of either mechanical or chemical engineers' meeting in New York in November, though Alvin M. Weinberg, Director of the Oak Ridge National Laboratory, admitted that "I tend to be the man from Missouri on fusion." Here are some of the reassurances:

"It is unreasonable to assume that the (radioactive waste) by-products of nuclear power generation constitute a problem which should impede the acceptance of nuclear power or delay the installation of the badly needed nuclear generating capacity," said J. A. McBride, Vice President of E. R. Johnson Associates, Inc., Washington, D.C., consultants. True, the long-term storage of the highly radioactive elements of this waste has yet to be resolved (see "The Unresolved Problem of Nuclear Wastes," by William W. Hambleton in *Technology Review* for March/April, 1972). Assuming current projections, some 50 million gallons of waste—or 500,000 ft.<sup>3</sup> if treated and stored as a solid—will be on hand in the year 2000. With underground storage now in doubt, the Atomic Energy Commission is proposing above-ground "engineered storage"; this satisfies Mr. McBride fully. Both containers and vaults will be "capable of retaining their integrity for the length of time required for the decay of the fission product activity," he assured the A.S.M.E.

An interesting figure from Frank Clark of the U.S. Department of the Interior, at the A.I.Ch.E.: If all the electric power used by one person in his lifetime were generated by a nuclear reactor, the high-level wastes resulting would fill a 16-oz. beer can. But that means storing and protecting—in monumental containers—several million beer cans a year.

Have we enough uranium to fuel fission reactors? Yes, if we can quickly perfect the breeder reactor, thinks J. J. Taylor of Westinghouse Electric Corp. He is confident we can: the breeder, which uses a far more plentiful uranium fuel—is well on the way to achievement. The discovery period—"the time when an unanticipated phenomenon



If all the electricity used by one U.S. resident in his lifetime were generated by a nuclear reactor, the high-level radioactive wastes resulting would fill only one 16-oz. beer can. But by the year 2000 nuclear power will be so widely used that some 50,000 ft.<sup>3</sup> of such wastes will be generated every year, and 500,000 ft.<sup>3</sup> of such wastes will have accumulated. Yet J. A. McBride of E. R.

Johnson Associates, Inc., finds no cause for alarm: "There appears to be no reason to believe that the above-ground storage vaults, or what the Atomic Energy Commission refers to as 'engineered storage,' is an unsatisfactory way of dealing with the problem of long-term waste storage," he told the American Society of Mechanical Engineers last fall.

might be discovered—is largely over," Mr. Taylor told the A.S.M.E. "We are now in the state of detailed engineering development and the conversion of a technically sound power generation concept to a highly reliable economic power generator."—J.M.

## Onward Forever?

Is there an ultimate limit to energy, from whatever source? Yes—but no one knows exactly what it is. That constraint will come when the energy that man introduces into the terrestrial system is a significant fraction of the solar energy on which the present character of Earth depends. What does "significant" mean in this case? No one knows.

David C. White, Ford Professor of Engineering at M.I.T. gave the A.S.M.E. (see above) these figures for thought: the energy received by the earth's atmosphere from the sun is perhaps  $3.75 \times 10^{21}$  B.t.u./yr. Man today consumes  $220 \times 10^{17}$  B.t.u./yr. on earth—roughly 6 parts to 100,000 of solar energy, "a truly very small factor."

But Professor White envisions human population and energy demands growing to a level at which energy production would reach  $1.4 \times 10^{19}$  B.t.u./yr.—almost 0.5 per cent of the solar input, "a ratio large enough to be of considerable concern." That time would come in only 75 years if energy consumption continues to gain at the current

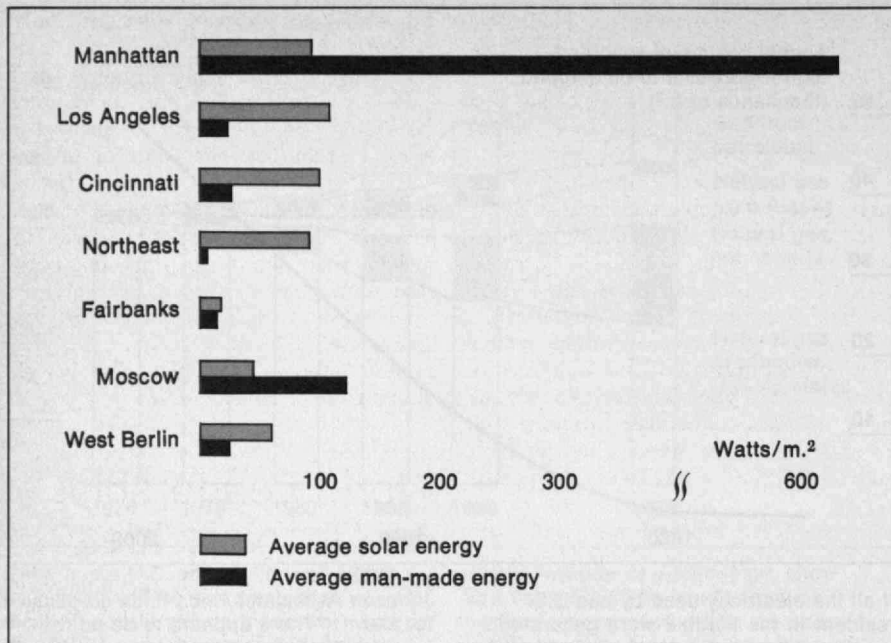
world rate. Considering that the industrial revolution is only 150 years old, "seventy-five years for developing societies to absorb and use already developed energy-intensive technology is not impossible or even improbable," Professor White told the A.S.M.E.

Chauncey Starr, Dean of the School of Engineering and Applied Science at the University of California—Los Angeles, expressed the same problem in a different way: "At the present average U.S. energy dissipation of 10 kw. per capita, a population of 30,000/mi.<sup>2</sup> (half New York City's density) will produce waste heat equal to the average solar heat loading of the atmosphere above it." Such an amount of heat release over an island the size of Manhattan, thinks Professor White, is self-serving: it pushes up the temperature, increases the demand for air conditioning, increases the production of energy . . . increases the demand for energy . . . —J.M.

### PERSPECTIVES

## Homo ?

Man used to call himself *Homo faber*, man the maker, as well as *Homo sapiens*, man the knower, to separate human from animal life. But that is too vague a distinction, as he found once he came to know his closer relatives and found that chimpanzees, for one, both make and use tools. He still



All man's energy must eventually end up as heat discharged into his environment. Today this man-made energy on a world-wide average amounts to 0.013 watts/m.<sup>2</sup> compared to 238 watts/m.<sup>2</sup> of solar energy reaching the earth; man-made energy is thus only six parts in 100,000 of solar energy, "a truly very small factor," admitted David C. White, Ford Professor of Engineering at M.I.T., in a summary paper for the 1972 annual meeting of the American Society of Mechanical Engineers. But the situation in large cities is very different. Data com-

piled by M.I.T.'s Study of Man's Impact on Climate (1971) show that in many metropolitan areas the heat release from energy consumption is approaching or exceeding that from the sun. Climate is averaged over regions much larger than metropolitan areas; but, as Professor White pointed out in citing these figures, there is a feedback effect at work: as more energy is consumed in a metropolitan area, conditions worsen and still more energy is needed to maintain air conditioners, pollution control devices, and other services.

lacks a definition of what human life is. His want acquires another facet as he learns to change and affect at least some of the physiological bounds that he has used to recognize what is human life and that have determined it. He can preserve life in an artificial lung, for example, or by an artificial pacemaker, long after the human would "naturally" have died.

Men might set up a number of criteria to judge whether a creature is human and alive, writes Joseph Fletcher, visiting professor of medical ethics at the University of Virginia Medical School, in the November, 1972, issue of *The Hastings Center Report*. Only by giving "operational definitions" to such words as man and person, he believes, can we make decisions involving ethics about what they describe. He has 15 attributes of humanness and five propositions about it.

A human has at least a minimal intelligence; Dr. Fletcher writes that "mere biological life . . . is without personal status," and an intelligence that counts up to below 20 on the Stanford-Binet test is "not a person." A human has self-awareness, and self-control; he has a sense of time and of having a future and of having a past.

He can relate to others and has concern for others. He is curious. He can communicate with others. He can change; he is idiosyncratic; he has a balance between rationality and feeling. A human can control his life: "he is not helplessly subject to the blind workings of physical or physiological nature. He has only finite knowledge, freedom, and initiative, but what he has [are] real and effective." Finally, he can use a specific part of his brain, the cerebral cortex, to synthesize the information his senses give him.

It is *not* necessary to reproduce to be human, Dr. Fletcher proposes. It is not necessary to have been sexually produced; that is, to have resulted from the natural joining of man and woman. Man is not anti- or non-artificial: a baby produced from a test tube might be more human, in Dr. Fletcher's terms, than one grown in a woman from an egg fertilized in sexual intercourse. A human need not have a religious faith.

And a human is not "a bundle of rights." Dr. Fletcher writes: "People sometimes speak of rights to live, to die, to be healthy, to reproduce, and so on, as if they were absolute, eternal, intrinsic. But as the law makes plain,

all rights are imperfect and may be set aside if human *need* requires it. We shall have to think through the relation of rights and needs, as it bears on clinical medicine's decision-making problems, as well as society's problems of health care delivery. One example: What is the 'humane' policy if we should reach the point (I think we will) of deciding for or against compulsory birth control?" Another example: "How are we to relate rights and needs if . . . after genetic counseling a couple elects to proceed with a predictably degenerate pregnancy?"

Dr. Fletcher expects corrections to his list but believes that we require such a list and we must use it.

He believes that "the 'nature of man' question is of such depth and sensitivity that it is bound to raise controversy, and our task is to welcome the controversy but try to reduce it through analysis and synthesis. We are more likely to find good answers inductively and empirically, from medical science and the clinicians," he writes, "than by the necessarily syllogistic reasoning of the humanities, which proceeds deductively from abstract premises. . . . Divorced from the laboratory and the hospital, talk about what it means to be human could easily become inhumane."—J.K.

## Geophysicians, Heal Thine Earth

Monte Canfield, Jr., recommends that we all become "geophysicians"—diagnosticians and healers of the earth—as a first step in developing a national energy policy. The U.S.A. has in fact become a nation of geodiagnosticians. We have become adept in identifying environmental and resource problems and in fingering culprits who may range from the oil industry to a litterbug. Earth healers are beginning to appear, and what they can do toward cleaning up the present mess will be welcome. More important, though, will be that their successes buy us time enough to develop a rational means of handling our energy resources, generation, and uses.

This is where Mr. Canfield comes in. He is coordinator of the Ford Foundation's Energy Policy Project, a two-year, \$3.5 million study expected to make recommendations by the end of 1973. In a talk before the New England Council for Economic Development last December Mr. Canfield suggested that governmental reform may be the key to implementing a new national energy policy, whatever that policy turns out to be.

Only seven years ago, in a report for the Office of Science and Technology,

a study group headed by Ali B. Cambel (see *Technology Review for March, 1967, pp. 46-48*) concluded: "In the light of present day technology, the nation's total energy resources seem adequate to satisfy expected requirements through the remainder of this century at costs near present levels." Widespread acceptance of this report is one of the reasons Mr. Canfield cites for what he considers the present unrealistic national policies that "call for low-cost energy and promote continued consumption."

The former Bureau of Land Management official fears that the nation will soon enter a tight-energy situation and will remain in it for a long time to come. Although there are plenty of fuel resources still in the ground, we have lost our ability to deliver them to market in an environmentally acceptable form.

"Obviously, we need to readjust our energy policies to the new needs," says Mr. Canfield. "The only way of assuring that a new energy policy will begin to meet [the requirements of saving the environment without pulling the plug on our standard of living] is by challenging all the most fundamental assumptions upon which the old policies were based." Some of the questions he hopes the Ford project will answer are:

□ How do lifestyles affect energy use and how will changing energy supplies and costs affect lifestyles? What are the effects of various energy systems on human health?

□ How have energy use, employment, and the economy interacted in the past, and how might they be expected to in the future?

□ Can land in the arid west be reclaimed after strip mining? What are the costs of clean energy and pollution control?

□ What is the projected range of prices for different kinds of energy to 1980 and beyond, and what effects might energy taxes and subsidies have on prices? What are the optimal sizes of companies in the energy industry? How much delay in power plant construction has been caused by opposition of environmentalists?

□ What effects is the growing global demand for energy having on international relations, which can be defined in part as a complex of economic, environmental, political, technological, and military problems?

□ What are the moral and political implications of the U.S.A., with 6 per cent of the world's population, consuming 35 per cent of the world's energy? What are the implications of the fact that we consumed 45 per cent of its energy 25 years ago?

Can the demand for energy be reduced? By how much? What steps can

be taken to conserve energy? Will it soon be necessary to ration gasoline? (John F. O'Leary, former Deputy Assistant Secretary of the Interior for Mineral Resources, expects such rationing to start in 1973.)

The Energy Policy Project will cover more than 50 such major study areas. This, of course, will result in an enormous mass of data; but will it do more than fill the project's paper bins? Mr. Canfield expects it to be orchestrated into a series of scenarios through which "the policy options will be analyzed as a coordinated whole" to try to avoid an energy crisis whatever pattern of growth the nation takes. There will be high-, middle-, and low-growth scenarios.

He suggests not waiting until the project is completed: we might begin two strategies now. They are: "cutting down energy demand through conservation; and improving the supply through a more concerted research and development effort." This will buy more time to develop new and clean sources of energy in addition to nuclear fission and fusion. Mr. Canfield believes some new energy techniques could be perfected by 1985, soon enough to provide some relief from the energy-environment crisis and to revive "hope for our high energy way of life."

Any such effort would require a critical mass of technical talent that does not now exist. Mr. Canfield sees success as depending on a reordering of the public and private institutions involved. He would consolidate federal energy research and development into a single mandated agency. But first he would establish a White House Council on Energy Policy to immediately start coordinating the work of the many involved agencies. In any case, it will be interesting to see what kind of preventive medicine the Ford project's geophysicians come up with.—R.S.

## A Human Architect

Pietro Belluschi began his architectural career determined that reason was "the law that governs the existence of form." But now he has come to understand "man's essential irrationality as part of his continuous process of being," he told the American Institute of Architects last summer upon receiving the A.I.A.'s coveted Gold Medal.

While he was Dean of the School of Architecture and Planning at M.I.T., said Mr. Belluschi, he was intent on preparing students "to take a leading role in the enormous, frustrating task of creating a shiny new environment fitting a lofty image of a great society." But perhaps today's architect must have a different goal: Let him understand, said Dean Belluschi, that "there

are really no ultimate solutions, only systems of change, doors that open and close, lights that illumine and darken." Let him accept technology "as a great tool" but learn "to suspect it when human passions want to be expressed." For that is when the artist in him, with the powers to express human passions, can perform greater service to society than we have thus far been able to imagine.

"Our strength must lie in the growth of our understanding of man, but we cannot embrace more than the length of our arms permits."—J.M.

## World Leadership: An Obsolete Idea?

The U.S. lead in high technology is eroding. But is this a cause for wailing and hand-wringing, or is simply a natural consequence of the world's growing economic maturity with which we must—and shall—learn to live?

Harvey Brooks, Dean of the Harvard School of Engineering, and Raymond L. Bisplinghoff, former Dean of M.I.T.'s School of Engineering who is now Deputy Director of the National Science Foundation, agree on the premise; but their answer to the question is very different.

In his address upon receiving the Godfrey L. Cabot Award of the Aero Club of New England early last summer, Dr. Bisplinghoff cited a series—alarming to him—of circumstances indicating America's deteriorating competitive position: U.S. manufacturing output per man-hour increased 34 per cent from 1960 to 1970, while that of 10 leading competitors rose 87 per cent; in 1971 Japan installed \$100 million more of metal-working equipment than the U.S.; between 1957 and 1970, the U.S. balance of trade in low-technology manufactured products went from a \$1 billion surplus (in our favor) to a \$6 billion deficit; by 1976 our present favorable balance of trade in aircraft will become negative, and by 1985 it will show a \$4.5 billion deficit.

"Unless there is some dramatic turnaround," said Dr. Bisplinghoff, "the U.S. is going to lose out in economic competition even in the areas in which it is now competitive." The country, he said, might "assume a second-rank position."

Dean Brooks would find Dr. Bisplinghoff's recital of circumstances less than alarming. Writing in the *Harvard Business Review* for May/June, he agrees that foreign-made high-technology products are indeed displacing American counterparts in world markets. But that is in the natural course of events: foreign countries are only now recovered in their technology from the

effects of World War II, by which U.S. technology and industry were less damaged than stimulated; J. Herbert Hollomon (see "Technology in the U.S.: Issues for the 1970s" in *Technology Review* for June, 1972, pp. 10-21) advances the notion that U.S. overemphasis on military and space-related research and development has cost us productivity in other sectors of the economy. And Dean Brooks agrees, but he also believes that "we are now due for a period of 'catch-up' in other areas"; other countries have been stimulated (like Avis) by "the extra incentive that always accompanies a number two position," and the world is growing ever smaller and more international—particularly in science and technology which are part of "an internationalized system in which knowledge and talent move with ever-increasing freedom."

Indeed, writes Dean Brooks, "the very concept of national superiority in science or technology is obsolescent." Rapid technological advance is giving way to an era of slower progress, and all nations "are approaching a common asymptote, . . . a condition of slower growth."

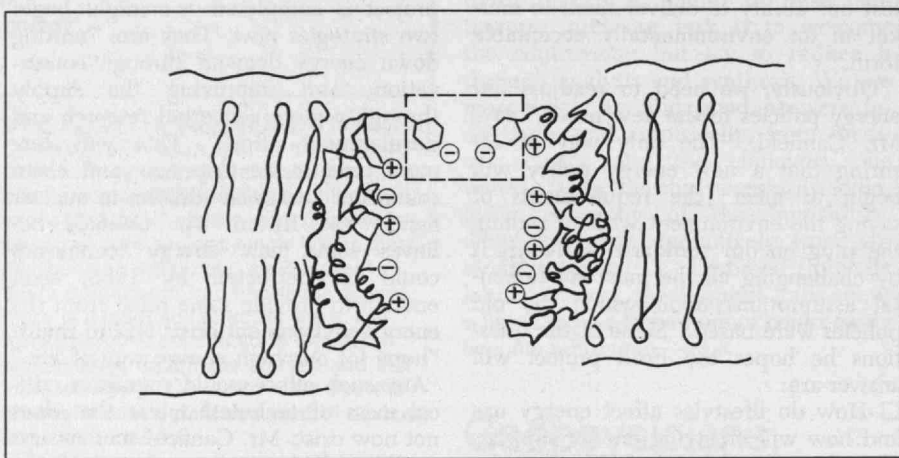
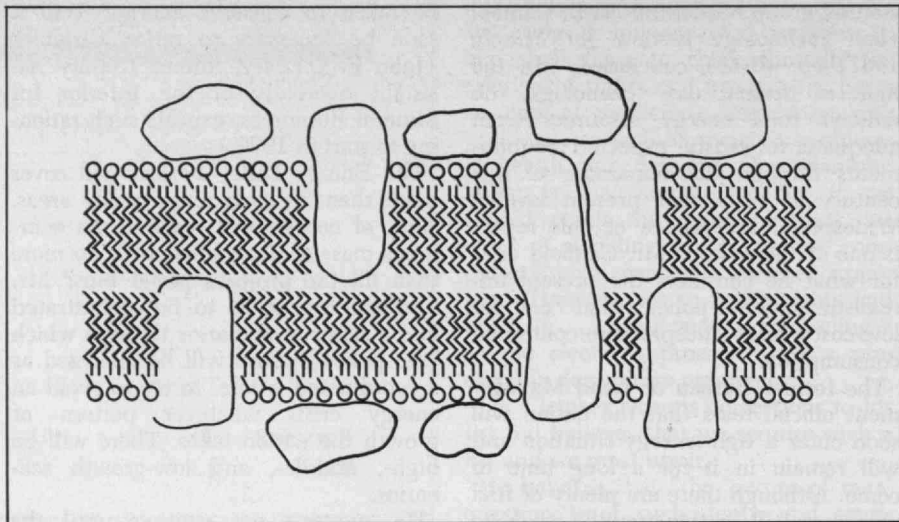
Less sanguine, Dr. Bisplinghoff urged a concerted effort to increase American innovation and hence productivity. But he admitted that the questions of how to stimulate innovation and what are the "elements of the total innovation process" are unresolved. Hoping for clues, the National Science Foundation will next year experiment with means to increase non-federal research and development investment and to convert its fruits most quickly into new products and new processes.—J.M.

#### LIFE SCIENCES

## In and Out of a Nerve Cell's Door

Proteins are very large, flexible, complicated, and fantastically versatile molecules. We are only beginning to understand how they work, how they carry messages, and orders throughout the body, how they manage and direct the huge number of chemical reactions that they do. One of the mysteries is their activity in cell membranes, in granting passage across them to one molecule and denying it to another; one of the types of cells they so serve is nerve cells, whose activity is known to depend on ionic movement.

The membrane of a nerve cell is basically two layers of fat molecules: of that much we are reasonably sure. That much was proposed 35 years ago by Hugh Davson of the University College in London and James Danielli



Two M.I.T. biophysicists are proposing a way for the membranes of nerve cells to control the passage across them of the ions that activate the cells. The membrane is basically two layers of fat molecules, according to an older theory, in which are placed protein molecules as shown in the upper sketch. A typical

protein that goes through both layers is shown below; it contains a channel through the membrane, passage through which is guarded by the polar sites in the box. The biophysicists believe that these sites change position as they bond to mono- and bi-valent ions to open and close the channel.

of the State University of New York. It was confirmed only last year, and then built upon by another biologist, J. Singer, of the University of California—San Diego. He believes that a number of balled-up protein molecules are scattered throughout that bilayer. And now two biophysicists from M.I.T., Kenneth J. Rothschild and H. Eugene Stanley, add to the model by suggesting that those molecules contain fast, precise, and tiny gates into and out of the nerve cell.

Some of the globular protein molecules go through both fat layers (see drawing) and these, Drs. Stanley and Rothschild propose, contain channels through the membrane. The gates are polar active sites in the channels that swing open and closed across them. Bonded to a bivalent ion, say, calcium, these polar sites are held close to each other and the gates are shut. This is the resting position. Bonded to a monovalent ion, such as sodium, the sites

swing apart and the gates are open. Drs. Stanley and Rothschild have no full explanation why the sites cling to either kind of ion, and why they switch: perhaps one, such as potassium, just by its presence bumps the other, such as calcium, out.

But the model looks promising. Other protein molecules, in other parts of the body, do contain channels and gates—the electron microscope has revealed a 10-A channel in a hemoglobin protein, —and the change from a resting to tense conformation is a common and perhaps a general mechanism by which proteins control much of the body's chemistry.

Each channeled protein, called a "permion," might allow only one substance to pass—it would be specific—but different ones would pass different substances, so the lot would be flexible in their control. The change from a resting to a tense posture can be almost instantaneous. And although Drs.

Rothschild and Stanley do not try to explain how the membrane as a whole and the individual permions respond to stimuli from other cells and thus initiate the transformation, the model can handle different chemical conditions outside of the cell. The ions that bind the sites in the tense state can be of the same substance as the ions that pass through or of a different one: sodium may bind the protein so sodium can pass, or potassium may open the gates for sodium. The gates can be cued to let molecules out of the cell as well, and to let molecules go alternately in both directions.

The mono- and bi-valent ions, potassium, sodium, and calcium, are present when nerve cells are active—sodium is the carrier of current inside the cell, and calcium seems to help in its regulation. The permion idea does explain how these all might interact. So Drs. Rothschild and Stanley are now looking for evidence that it does.—J.K.

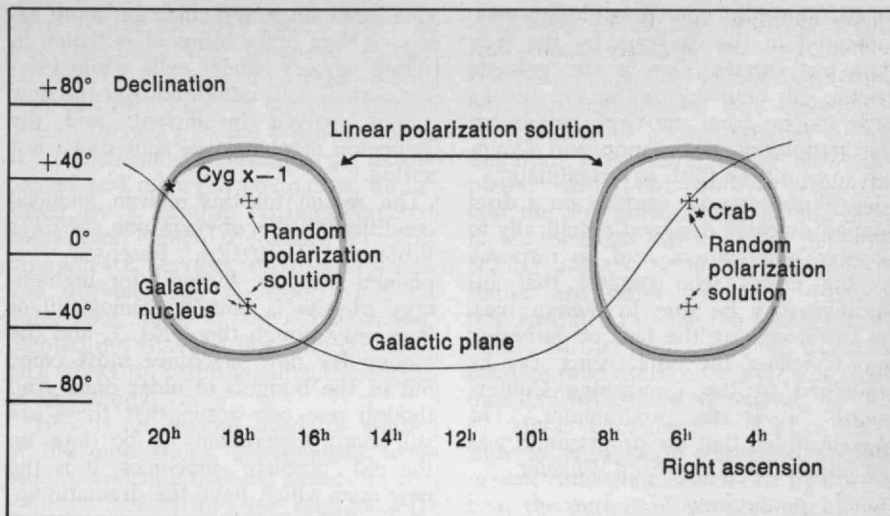
#### PHYSICAL SCIENCES

## What Are the Gravity Waves Saying?

One of the consequences of the general theory of relativity is that a massive object, either accelerating or undergoing a change of mass, should give off gravitational radiation. Such radiation should be detectable as an oscillatory force on any other massive body. So far, one researcher claims to have observed gravity waves—Dr. Joseph Weber, of the University of Maryland—while a number of others are preparing apparatus which ought to detect the waves if they really exist, and relativity theorists are attempting to explain Dr. Weber's observations quantitatively.

Last summer the fourth "Cambridge" Conference on Relativity was held in Cambridge (not always the case, it being a relativistic event). The aim of the "Cambridge" conferences is to bring together every experimental team in the world which is working on general relativity. This year there were just 23 papers (nine more than at the last conference) and of these, 13 concerned gravity waves. Since gravitational radiation is only one of eight possible gravity effects of general relativity, this represents something of a smash hit in the physics community.

Dr. Weber's basic "antenna" consists of an aluminum cylinder weighing a ton and a half, fitted with a piezoelectric (transducing pressure into electric current) strain-detector and suspended in a vacuum. He uses a pair of these, a few hundred miles apart, and counts only the occasions when both their



According to the general theory of relativity, there should be such a thing as gravity waves—analogueous to electromagnetic radiation, with gravitational force in place of electromagnetic forces. One experimenter has been detecting gravity waves since 1969, and a number of theorists are at work on the question of where they might be coming from. Two of the latter have produced this map of the sky, on the

basis of two possible assumptions: the waves might either be 100 per cent linearly polarized, in which case they would have come from somewhere in the two thin oval bands; or they might not be polarized at all, which would mean that their direction of origin is one of the four error-bar crosses. (D. H. Douglass and J. A. Tyson: paper submitted, at this writing, to *Astrophysical Journal*).

electric outputs register a blip simultaneously. Numerous skeptics are constantly on the watch for faults in his apparatus or his statistics which could generate spurious "events," but he appears to be satisfying most of these critics.

The rate at which the bursts of apparent gravity radiation occur varies with the time of the day and year, suggesting that the radiation comes from a single region in space—in the direction of the galactic center. However, it has been calculated that if the source really were at the center of the galaxy, to produce the intensity observed at that distance it would be necessary for matter to be disappearing at a rate of about ten thousand solar-masses per year. The galaxy does not contain enough stars for this kind of thing to go on for very long.

Last April, Charles W. Misner (also of the University of Maryland) suggested that a more reasonable source of gravity waves, still at the center of the galaxy, would be a rotating "black hole" (an object with a gravitational field so powerful that though more matter can enter it nothing can escape). Such an object could concentrate its emissions of gravity radiation into the plane of the galaxy, giving the observed intensity at Maryland with a very much smaller consumption of matter (*Physical Review Letters*, Vol. 28, pp. 994-998).

Moreover, the radiation would be polarized. The Weber cylinders, being linear objects, would give a different

output depending on the direction of polarization. In the same issue of *Physical Review Letters* (pp. 991-994), J. A. Tyson and D. H. Douglass, of Bell Telephone Laboratories and the University of Rochester respectively, therefore reexamined Dr. Weber's observations to discover what degree of polarization would be consistent with their source being at the galactic center. The answer was anywhere between zero and 40 per cent polarization, which led Drs. Tyson and Douglass to conclude that Dr. Misner's rotating black hole would not do; and that what the theorists ought to devise was an object that concentrated its gravity-waves without polarizing them very much.

The ability to perform this kind of calculation led Drs. Tyson and Douglass to a further pair of questions: First, if Dr. Weber's waves were in fact 100 per cent linearly polarized, what direction would they be coming from? Not from the galactic center, clearly. They would be coming from some point on one of the two oval bands shown in the diagram, the researchers told the Cambridge Conference. Of the known astronomical objects lying in these bands, perhaps the most interesting is the x-ray source called Cygnus X-1, which could—according to observations this year—contain the right kind of object (a black hole); but the latter seems far too small. The second, complementary question is where the waves could be coming from if they were not polarized

at all. There are four possible answers, indicated in the diagram by the four error-bar crosses. One is the galactic center, of course; another is just a little too far from the Crab nebula for the scrupulous Drs. Tyson and Douglass to count the Crab as a candidate.

Dr. Weber is now working on a disc-shaped detector designed specifically to observe polarization. And, in response to the critics who suggest that his findings may be due to human bias, he is automating the task of gathering and checking the data, using (as he explained to the Cambridge Conference) "a hostile programmer." Dr. Weber added that the programmer was not hostile initially.—*Fred Wheeler*

## What's New In "Big Physics"

Recent reports on "big physics"—the work that involves huge, multi-million dollar accelerators—have been mixed. On the one hand, impressive new machines are coming into service; among them are M.I.T.'s new \$7 million, 400-MeV. linear electron accelerator, the \$57-million, 800-MeV. linear proton accelerator at Los Alamos, and grandest of them all, the huge new \$250-million, 200-GeV. (giga-electron-volt,  $10^9$ eV.) proton synchrotron at the National Accelerator Laboratory in Illinois.

But elsewhere the physics business seems less prosperous. The budget of the M.I.T.-Harvard Cambridge Electron Accelerator, a synchrotron once used for a large variety of experiments, declined ominously for years. The C.E.A. finally escaped extinction only through a complete refitting that makes it into a new sort of machine suitable only for a new and somewhat limited range of experiments. (Instead of accelerating a beam of electrons to release against a stationary target, it will accelerate oppositely-traveling beams of electrons and positrons to collide head-on against each other.)

At the University of California at Davis, the medium-energy proton accelerator is "moonlighting" for the state's air pollution control program. When the proton beam strikes an air sample, the resulting x-ray spectrum identifies the pollutants. The procedure is said to be cheaper to the state than standard chemical analysis, it allows the accelerator to turn a small profit, and it still leaves some time for physics.

And when the A.E.C. decided in 1970 that the Princeton Particle Accelerator (a three-GeV. proton accelerator) was expendable, the Princeton scientists looked to cancer research for a new source of cash. They converted their machine into a heavy-ion accelerator;

ions, it is suspected, may be more selective than other forms of radiation in acting against cancer cells while leaving normal cells uninjured. But the new money proved insufficient, and the Princeton machine was shut down last spring.

The reason for this uneven financial condition is the obvious one, M.I.T.'s Professor Lawrence Rosenson explained recently. Support for high-energy physics is limited (almost all of it comes through the A.E.C.), and the money for new machines must come out of the budgets of older ones. And though one can argue that there are still many experiments to be done on the old "obsolete" machines, it is the new ones which have the dramatic appeal.

Not all of the new machines push for high energy. The Los Alamos proton accelerator and the M.I.T. electron accelerator are examples of a new breed of "moderate-energy" machines. Although their energy is unimpressive, these accelerators provide unprecedented levels of precision and intensity (beam "current").

The dominant phenomena at energies in the hundreds of MeV. have been explored already; what interests physicists now are the anomalies and the details—the rare events and detailed effects which can be observed only once in every few million tries or only under very special circumstances. These new machines are designed to look for these phenomena.

Heavy-ion beams, mentioned above, are another new development. When a heavy projectile like a nitrogen nucleus goes crashing through the electron shells of a target atom, it produces x-ray spectra never before observed. And when it lands in the nucleus, it can remain there, sometimes producing the "super-heavy elements" of interest to nuclear chemists. Radiobiologists, as already mentioned, are also interested in heavy-ion beams, and astronomers find that such beams can simulate cosmic rays.

The accelerator is only half the apparatus needed to conduct an experiment; one must also have detectors, and be able to analyze what happens after the particles interact. The new detection techniques all aim to facilitate the use of digital computers—virtually indispensable for handling the vast quantities of data generated.

The spark chamber is one venerable concept: the gap between a pair of charged electrodes is filled with a gas; an entering particle ionizes enough gas to set off a spark. Today, huge arrays of these devices are connected to a computer to plot a particle's course through them.

The "proportional" array uses an old variation on the spark chamber, in

which the voltage on the electrodes is not great enough to give a spark but is enough to collect any ions formed in the gap, as a tiny current. Today's cheap large-scale-integrated circuits provide a means of amplifying the current from each of, again, a very large number of separate elements. In this case, the signals going to the computer are proportional to particle energy.

"Big physics" is affected, like most human endeavors, by the state of the technological art. Old machines give way to new ones, in obedience to both a scientific and a technological imperative.—*O. Reid Ashe*

## ECONOMICS

## To Reinvigorate U.S. Philanthropy

Is the charitable deduction—fundamental in the federal income tax since it was first collected in 1917—a tax "loophole" for the rich, destined to be eliminated as tax reformers press their work in the current decade?

Tax immunity for income given as philanthropy is no special privilege. Yet the attack upon it is strong, writes Alan Pifer, the distinguished President of the Carnegie Corporation, in his 1972 annual report. Indeed, he writes, "there is considerable public ignorance of the role which the charitable sector plays in our national life and a kind of pervasive indifference to its fate."

Dr. Pifer hypothesizes that the threat to the charitable deduction stems from misimpressions fostered by the political pressure on tax "loopholes" and the growing reliance upon government for public services:

□ "The fact that the tax 'savings' involved in charitable gifts . . . go to the recipient institutions and not into the pockets of the donors is easily overlooked," he said.

□ "To some Americans, charity has apparently become uncoupled from the notion of public benefit and tied instead to the idea of private advantage and privilege."

□ Another popular but erroneous assumption, said Dr. Pifer: government has first claim on every citizen's income, and its grant of tax immunity is simply an act of generosity. Neither is the case.

□ The government seems to consider that having "granted" donors the "privilege" of a deduction, it has in fact granted a subsidy to the recipient institution, making it somehow less than wholly private.

□ Government decision-making is seen by some to be preferable to private choice when affecting funding intended to be of public benefit.

Private philanthropy by definition serves the public welfare, writes Dr. Pifer; it provides "qualities which are indispensable to the humane, enlightened, and free society," and government should be obligated to pursue the general welfare through private as well as public initiative.

Clearly, writes Dr. Pifer, "the time has come when steps must be taken to rehabilitate and reinvigorate this basic concept in our national life."—J.M.

## The Evolving Multinational

Jean-Jacques Servan-Schrieber, the French journalist-turned-politician who wrote *The American Challenge*, now sees Europe as threatened not simply by American business but more fundamentally by the multinational corporations. Looking at it from this side of the Atlantic, Richard D. Robinson of M.I.T.'s Sloan School of Management sees the multinational corporation as evolving away from any loyalty to its original parent nation. At least some of these corporations, having passed through a phase of rather tenuous decentralized control, have reached a stage where the management talent of many nations is being promoted from local divisions to headquarters.

If a corporation's gross revenues are considered comparable to the G.N.P. of a country, Professor Robinson pointed out at the Sloan School's 20th Anniversary Convocation last fall, the top 100 institutions are about evenly divided as between nations and companies, and in general the latter are growing faster. The question arises as to how to bring law and order to the activities of entities of this size that owe no allegiance to any established polity.

Professor Robinson sees a need for international regulators, although their establishment and effectiveness hinge upon the willingness of each nation to relinquish some degree of sovereignty. (Eugene B. Skolnikoff, in "Technology and the Future Growth of International Organizations"—*Technology Review* for June 1971, pp. 38-47—arrives at the same problem area from an examination of modern global-scale technologies.) The sacrifice of national freedom for the sake of international order is being accepted in various forms in Western Europe. Nations remaining relatively aloof from such liaisons, such as Canada and the U.S., are beginning to fight off the growing "supranational" business threat by restraining such businesses from buying up more of their nations' companies.

Against such resistance, perhaps the multinational corporations will not be able to grow much bigger and will

have to take on other forms. There is, for example, "the Japanese model" favored by Professor Robinson, which does not lend itself to the incursion of other nationals into the top boardroom. It consists of a collection of locally owned and managed companies, all assisted by a central Japanese-directed corporation which specializes in capital-intensive services such as research and development. Professor Ithiel de Sola Pool, also at the Convocation, pointed out that the Japanese model in fact works to institutionalize the export of technology.

There is an obvious need for studies of the motivations, management techniques, and international economic and political effects of the multinational corporations. Professors Robinson and Pool described plans for such a research program to be run by the Sloan School in collaboration with M.I.T.'s Center for International Studies that would address such little-explored issues as:

- The multinationals' sources of capital;

- The belief espoused by Representative James A. Burke and Senator Vance Hartke that U.S.-based multinationals are creating job opportunities overseas while destroying them at home;

- The way such companies assess their local political environments;

- The kinds of agreements arrived at between multinational companies and local governments.—Fred Wheeler

### TRANSPORTATION

## Toward Clean Jets and Cleaner Airports

Air pollution caused by turbine engines in commercial jet aircraft can be significantly reduced by changes in engine configuration and in airport ground operating procedures. Some can be incorporated into existing aircraft and airports; others can be made only in aircraft yet to be built or at greater expense for airport redesign.

These conclusions from research sponsored by the Environmental Protection Agency at the Northern Research and Engineering Corp. were reported this winter to the American Society of Mechanical Engineers; the work will be the basis for E.P.A. aircraft emission control standards. The A.S.M.E. report was by E. K. Bastress, now manager of environmental research at IKOR, Inc.; Colin F. Robertson, now at the Imperial College of Science and Technology, and G. E. Smith and R. C. Baker of N.R.E.C.

### Engine Modifications

Five modifications to existing jet engines were suggested to reduce the

discharge of pollutants in various stages of the operating cycle:

- Minor changes in combustion chambers and fuel nozzles will change air-flow and fuel spray patterns within engines. This work could be completed within two to five years and cost the airlines \$270 million to implement; some has already been done, resulting already in lower emissions of smoke and other pollutants. Engines thus modified provide the baseline from which further reductions in pollution through additional changes were calculated by Northern Research.

- Major combustion chamber redesign to incorporate advanced fuel-injection concepts has reduced by 50 per cent the output of particulates by advanced JT9D and CF6 engines on the new wide-body jets. To install such systems on all operational aircraft may cost as much as \$520 million. The job could be done in five to eight years.

- Fuel supply system modifications to allow some fuel nozzles of jet engines to be shut down during low-power operation; this might reduce by as much as 75 per cent emissions of all pollutants—carbon monoxide, hydrocarbons, and particulates; its cost for development and installation on a retrofit basis might be \$55 million over the next five years.

- When an engine delivers its maximum power (during take-off and climb-out), it produces the most nitrogen oxides. A water-injection system used at those times would reduce NO<sub>x</sub> emissions by 75 percent. Its cost during a four-year implementation period on all air carriers might be \$120 million.

- Engine changes to reduce the flow of air through the combustion chamber during low-power operation (increasing the bleed air rate from the compressor) would increase the fuel-air ratio, increase efficiency, and reduce carbon monoxide and hydrocarbon emissions by half during idle and taxi operations. The job can be done in six years at a cost of about \$75 million.

### Engine Design Changes

Two engine design changes are deemed possible only for new engines built following their adoption; retrofitting in existing engines is simply impractical:

- A variable-geometry combustion chamber would constantly maintain the proper air-fuel ratio for most efficient operation in all operating conditions. It would provide "substantial reductions" of carbon monoxide and hydrocarbon emissions at low power; and with an advanced fuel injection system providing premixing of fuel and air would also achieve "substantial reductions" of NO<sub>x</sub> and particulates.

- Similar reductions of all pollutants would be possible with "staged injection"

tion" combustors, in which combustion occurs in discrete steps during the flow of air through the combustion chamber.

Fitting future aircraft engines with these modifications might increase their cost by 3 to 4 per cent, according to Northern Research estimates.

### Ground Operations

Four new ground procedures were suggested to reduce pollution:

- Increase engine idling speeds so that engines operate more efficiently; if this were implemented at Los Angeles International Airport (whose operations were chosen by Northern Research for analysis as an example) 30 per cent of carbon monoxide emissions and some 10 per cent of present hydrocarbon emissions from aircraft on the ground would be eliminated. (But E.P.A., preparing to publish such a regulation for comment, wonders if the increased wash from faster-idling jet engines would break terminal windows and damage nearby aircraft.)

- Use one or two engines instead of three or four for taxiing; at Los Angeles this change and the use of higher idling speeds (above) would reduce pollutants by 35 to 60 per cent, depending on the aircraft involved.

- Control gate departures so that aircraft leave terminal gates only when they can be promptly cleared for take-off. (This plan, though considered "feasible," would require "a complicated computer-based system with automated communication techniques.")

- Use auxiliary power supplies in place of on-board units while aircraft are at their gates.

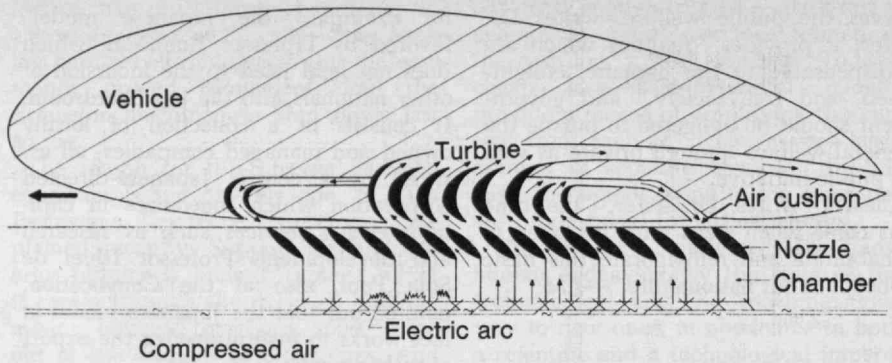
- Remove fuel from aircraft drainage reservoirs by returning it to the fuel tanks instead of discharging it during take-off.

On-the-ground pollution could be reduced if aircraft are left near runways with passengers transferred in auxiliary vehicles, or if aircraft are towed from runways to terminals. But Northern Research admits that these alternatives introduce pollution from towing or transport vehicles.—J.M.

### DEVICES

## Radar View of Earth

Radar is now routinely used to study the topography and surface characteristics of nearby planets, supplementing and helping to interpret data from spacecraft (see Professor Thomas Gold's "The New Planetary," *Technology Review*, Oct./Nov. 1969, pp. 42-45). Astronomers' ability to interpret surface characteristics from radar data may now be increased by earth-based radar studies of the earth itself.



A compressed air conduit with a series of nozzles to be tapped by a passing vehicle provides the motive power for Yan Wu's proposed tracked air-cushion air-driven rapid transit system. Electric arcs triggered by the vehicle's arrival

would heat and thus further compress the air behind each nozzle. Discharged into the vehicle's turbine, the air would force the vehicle forward; and air bled from the turbine would provide the cushion on which the vehicle would ride.

Improvements completed at the Arecibo (Puerto Rico) radar telescope early this year have made it possible to detect a radar beam directed to the moon, reflected from there to the earth's surface, reflected again from earth to the moon, and thence received at Arecibo. The returned "triple bounce" signal is 10 billion times fainter than conventional one-trip radar signals returned directly from the moon to earth.

The importance of the technique is the opportunity it promises for astronomers to obtain radar images of known terrestrial features with which to compare images of unknown features on other planets. And it may also yield a new perspective on the earth: Gordon S. Pettingill, Professor of Planetary Physics at M.I.T. who has been associated with Donald Campbell and Rolf Dyce of the National Astronomy and Ionosphere Center at Arecibo, now awaits "triple-bounce" data which seem likely to yield a measure of the average wave slope of water in a known region of ocean, either in the Atlantic or the Caribbean (depending on where the sub-lunar point of the earth was during a given run).

Correlation of this measure with direct surface records will be rough at best, due to the fairly long radar wavelength (70 cm.), the complexities of the interpretative theory used, and the incomplete, intermittent availability of ordinary oceanographic records. "We have just crossed the threshold" of this new technique, says Dr. Pettingill. In two years' time the sensitivity of the Arecibo telescope will be increased 100-fold, greatly improving the signal-to-noise ratio and the area-resolution with which the surface can be viewed. And the Skylab satellite, next year, is

expected to permit radar studies of earth at shorter wavelengths (and, of course, from much nearer).—J.M.

## Train for All Seasons

Riddle: name a transportation system designed for all speed ranges and all vehicle sizes, useful for urban or intercity transit, good for one person or thousands, runs on wheels or air cushion with or without track, produces an exhaust of clean air, carries neither electric nor combustion engine . . .

Answer: a compressed-air vehicle, drawing energy from a compressed-air utility beneath the streets or guideways on which the vehicle will run. As a locomotive draws electricity off overhead wires, this vehicle picks up jets of highly compressed air and converts their energy into motion. If a high-voltage electric line parallels the compressed-air pipe, the vehicle's approach can trigger an arc to superheat the compressed air, thus increasing its thrust. Decompressed air exhausted from the vehicle can serve as an air cushion, if one is needed. And if a battery, electric motor, and compressed-air-driven generator can be added, the vehicle achieves off-system mobility.

Will it work? Yau Wu, Associate Professor of Aerospace Engineering at Virginia Polytechnic Institute, makes no promises. All kinds of engineering design must be done on compressor, pipe and intersections, storage tanks, nozzles, turbines, air cushion or airfoil, and controls. Then there are such questions as noise, safety, dynamic stability, and economy. But he thinks the plan deserves serious study and evaluation.—J.M.



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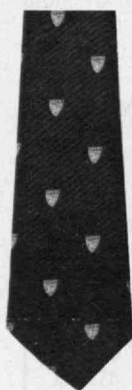


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TR-71

# Geometry, Milk, and a Norwegian

**Puzzle Corner:**  
**Allan J. Gottlieb**

My graduate school tenure has nearly ended. Things are getting pretty hectic. Right now Alice and I are typing my thesis and I am frantically trying to learn German. Things are so tight that today, January 1 (Happy New Year!), I am watching only one football game. What a sacrifice!

Harry Nelson puzzle creations are available from the creator at Box 643, Livermore, Calif.; write him for details.

**Problems**

The following novel bridge problem is by Walter F. Penny:

**FEB1** A scrambled sequence of letters is formed by choosing a key word (containing no repeated letters) and writing the remainder of the alphabet in order after it. The letters of this sequence are written as capitals on the 26 cards ♠A through ♥2. The letters of another sequence (based on a different key word) are written as lower case on the 26 cards ♦A through ♣2. On this basis a bridge game, with a contract of four spades held by south, might be written as shown in the box at the bottom of the page. What are the key words?

A geometry problem from John T. Rule:

**FEB2** Given a parallelogram ABCD. Choose two random points M and N on the parallel sides AB and CD. Draw MC, MD, NA, and NB and intersecting at E and F. Prove that the line EF divides the parallelogram into two equal areas.

This long division puzzle was submitted by Fred Heutink, who writes that the first reaction of Puzzle Corner fans "is likely to be, 'This is impossible; there must be a misprint. And what is the meaning of that X?' I have been very diligent about not making misprints (and so have the editors). And the meaning of the X will become clear as the problem progresses. No cheap tricks like leading zeros are used. But you do have to climb out of your comfortable rut in order to get around the apparent impossibility."

**FEB3** Fill in the dashes with digits -5--3-)9----- to make it a correct long division:

7-4-

-5--3-)9-----

---1--

---X-

-1---7

--2---

----0

4----

-----

0

Here's one for animal fans from Bruce (no relation to Bobby) Orr:

**FEB4** Who drinks water? And who owns the zebra?

1. There are five houses, each of a different color and each inhabited by men of different nationalities, with different pets, drinks, and cigarettes.
2. The Englishman lives in the red house.
3. The Spaniard owns the dog.
4. Coffee is drunk in the green house.
5. The Ukrainian drinks tea.
6. The green house is immediately to the right (your right) of the ivory house.
7. The Old Gold smoker owns snails.
8. Kools are smoked in the yellow house.
9. Milk is drunk in the middle house.
10. The Norwegian lives in the first house on the left.
11. The man who smokes Chesterfields lives in the house next to the man with the fox.
12. Kools are smoked in the house next to the house where the horse is kept.
13. The Lucky Strike smoker drinks orange juice.
14. The Japanese smokes Parliaments.
15. The Norwegian lives next to the blue house.

This one, from Judith Q. Longyear, looks kinda tough to me:

**FEB5** In each 0 1 2 3 4 5 6 . . square of an infinite 1 0 3 2 5 4 . . checker board, put 2 3 0 1 6 . . the smallest (no 3 2 1 0 7 . . negatives) integer 4 . . not already occurring to the left in . . that row or above in that column. What number is in the 19th row and the 38th column?

**Speed Department**  
In accordance with the plan announced last month, we publish at the end of this

month's column the answers to the following two "speed" problems:

An easy one, for a change, from R. Robinson Rowe:

**SD1** How many *Review* readers have noticed that "Institute" is divisible into three three-letter words (see right)? Now that they've noticed, let them equate each letter to a different digit so that the indicated summation will make MIT the greatest. Then identify 42657 as one of its lyrical symbols.

I N S  
T I T  
U T E  
-----  
M I T

Joseph Horton wants you to:

**SD2** Find English words containing the following letters consecutively in the given order:

a. WSST

b. YCAM

c. PERMI

d. BPOE

e. EIPT

f. NDICT

g. SIMMO

**Solutions**

The following are solutions to the problems published in the October/November (1972) issue of *Technology Review*:

**O/N1** Suppose your arrogant chess opponent, instead of just giving you the first move, lets you set up your pieces in any positions you want, as long as you keep them on your half of the board. He then reserves to himself the privilege of first move (his pieces begin in the normal position). What is the best arrangement in order for you to force mate as quickly as possible?

I believe the proposer, Douglas Goodman, has the best solution:

The following particular position of pieces is "best" among positions which mate in two moves in the sense that it can be reached in the fewest legal moves from the normal starting position (the underlined pieces are the crucial ones).

R	N	B	Q	K	B	N	R
P	P	P	P	P	P	P	P
P		<u>N</u>	P	<u>N</u>	<u>Q</u>		P
				<u>R</u>	<u>R</u>	P	<u>B</u>
	P	P		P	P		
		B		K			

The moves to reach it are:

1. -- N-KB3

2. KN-Q6 (check), BPxN

3. NxP (mate)

or

1. -- P-K3

2. QxKBP (mate)

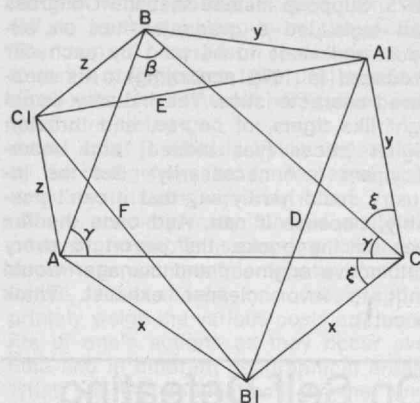
Since this is an original problem, it is possible that there is a better solution—but I doubt it very much.

Also solved by 24 other Puzzle Corner readers: John B. Allen, Ted Altman, Albert Bingaman, Gerald Blum, Ray Brinker, Joseph Carr, Andrew Fink, Brian Forst, Peter Groot, Walter Hausz, Doug

W	N	E	S	W	N	E	S	W	N	E	S	W	N	E	S	W	N	E
H	Z	Y	R															
G	W	P	D															
			V	O	B	F												
			E	T	S	C												
			p	a	e	t												
			d	r	c	h												
				o	i	b	A											
							Q	M	J	U								
								x	z	f	u							
									y	L	s	X						
										N	g	K	I					
											j	w	v	n				
												l	q	k	m			

Hoylman, Jon Kelly, Julius Leonhard, Brian MacDowell, Roy McDonald, Harry Nelson, Robert Potash, Roy Schweiker, Steve Shalom, Lee Sheridan, Michael Speciner, Michael Sutherland, Herve Thiriez, and Luis Villolobus.

**O/N2** On the sides of a triangle ABC are erected three isosceles triangles with base angles of  $15^\circ$  and vertices  $A'$ ,  $B'$ , and  $C'$  external to ABC. Prove that triangle  $A'B'C'$  is equilateral.



As many noticed, the angle should have been  $30^\circ$ . The following solution is from Bogdan Marcovici, who calls it a "simple-minded trigonometry" solution:

Let angle  $BAC = \alpha$ , angle  $ACB = \gamma$ , and angle  $CBA = \beta$ . Let  $CB' = AB' = x$ ,  $CA' = A'B = y$ , and  $AC' = C'B = z$ . Let angle  $BCA' = \text{angle } A'BC = \text{angle } B'CA = \text{angle } B'AC = \text{angle } C'AB = \text{angle } C'BA = \xi$ . Let  $A'B' = D$ ,  $A'C' = E$ , and  $B'C' = F$ . Then, by the law of sines,  $AC/\sin \beta = BC/\sin \alpha = AB/\sin \gamma$ ; and  $AC = 2x \cos \xi$ ,  $BC = 2y \cos \xi$ , and  $AB = 2z \cos \xi$ .

Since  $AB'C$  is isosceles, etc., we have

$$x/\sin \beta = y/\sin \alpha = z/\sin \gamma = K.$$

Since the triangle is arbitrary, let  $K = 1$ ; thus  $x = \sin \beta$ ,  $y = \sin \alpha$ , and  $z = \sin \gamma$ . Since the angle  $B'CA' = \alpha + 2\xi$ , etc., and using the law of cosines, the lengths  $D$ ,  $E$ , and  $F$  are given by:

$$D^2 = \sin^2 \beta + \sin^2 \alpha - 2 \sin \beta \sin \alpha \cos (\gamma + 2\xi)$$

$$E^2 = \sin^2 \gamma + \sin^2 \alpha - 2 \sin \gamma \sin \alpha \cos (\beta + 2\xi)$$

$$F^2 = \sin^2 \gamma + \sin^2 \beta - 2 \sin \gamma \sin \beta \cos (\alpha + 2\xi)$$

Assuming  $\exists \xi$  such that  $D = E = F$ , the condition for, say,  $D = F$  is  $\sin^2 \alpha - 2 \sin \beta \sin \alpha \cos (\gamma + 2\xi) = \sin^2 \gamma - 2 \sin \gamma \sin \beta \cos (\alpha + 2\xi)$ , after cancelling  $\sin^2 \beta$ .

Equivalently,  
 $\sin^2 \alpha - \sin^2 \gamma = 2 \sin \beta [-\sin \gamma \cos (\alpha + 2\xi) + \sin \alpha \cos (\gamma + 2\xi)]$ . (1)

Since  $2 + \beta + \gamma = 180^\circ$ ,  $\sin \beta = \sin (\alpha + \gamma)$ .

Also, since

$$\cos (\alpha + 2\xi) = \cos \alpha \cos 2\xi - \sin \alpha \sin 2\xi, \text{ and}$$

$$\cos (\gamma + 2\xi) = \cos \gamma \cos 2\xi - \sin \gamma \sin 2\xi,$$

the parenthesis in (1) equals

$$-[\sin \gamma \cos \alpha \cos 2\xi - \sin \gamma \sin \alpha \sin 2\xi - \sin \alpha \cos \gamma \cos 2\xi + \sin \alpha \sin \gamma \sin 2\xi]$$

$$= -\cos 2\xi [\sin \gamma \cos \alpha - \sin \alpha \cos \gamma]$$

$$= -\cos 2\xi \sin (\gamma - \alpha)$$

$$= \cos 2\xi \sin (\alpha - \gamma).$$

Thus (1) implies

$$(\sin^2 \alpha - \sin^2 \gamma) = 2 \cos 2\xi \sin (\alpha + \gamma) \sin (\gamma - \alpha)$$

$$= 2 \cos 2\xi \sin (\alpha + \gamma) \sin (\alpha - \gamma).$$

$$\text{But } \sin^2 \alpha - \sin^2 \gamma = \frac{1}{2}[1 - 2 \sin^2 \gamma - 1 + 2 \sin^2 \alpha]$$

$$= \frac{1}{2}[\cos 2\gamma - \cos 2\alpha] = \frac{1}{2}[-2 \sin (\alpha + \gamma) \sin (\gamma - \alpha)]$$

$$= \sin (\alpha + \gamma) \sin (\alpha - \gamma).$$

Hence the condition (1) implies

$$2 \cos 2\xi = 1,$$

$$\cos 2\xi = \frac{1}{2}, 2\xi = 60^\circ, \text{ and } \xi = 30^\circ.$$

The same argument obviously can be used to show that  $D = E$ , which implies  $D = F = E \rightarrow A'B'C'$  is equilateral.

Also solved by 27 other readers: Allen Andersson, Adam Apt, Edward Barry, Gerald Blum, K. J. ("Charlie") Bossart, Jorge D'Almeida, Zachary Gilstein, Kyochi Haruta, Walter Hausz, K. Heindlhofer, I. L. Hopkins, Winthrop Leeds, Edward Mowka, Mark Novak, Harold Phinney, Robert Potash, Robert Rogoff, R. Robinson Rowe, John T. Rule, Donald Savage, Gilbert Shen, K. Schoenherr, Jay Sinnett, David B. Smith, Norman Wickstrand, J. Woolston, and Harry Zarembo.

**O/N3** We cover the globe with a set of geodetic points in such a way that the distances from any point to three of its closest neighbors are the same. If we further stipulate that one of the points lies in Cambridge, Mass., and that another one lies due north of the first one, (1) what is the location of the second point? and (2) how many points fall in the U.S.? Assume the earth to be a perfect sphere.

The following is from R. Robinson Rowe:

For a geodetic net as described, its points must be the vertices of an inscribed regular polyhedron. With equal distances from each point to its three nearest neighbors, there must be three edges converging at each vertex, such as in a tetrahedron, cube, or dodecahedron. To have one point in Cambridge at latitude  $N 42^\circ 22'$  and another due north,

the edge length must be less than the polar distance of  $47^\circ 38'$ , which limits the choice to the dodecahedron. With this edge fixed, the geographical coordinates of the 20 dodecahedral vertices have been computed and are shown in the table at the bottom of the page in longitudinal order with a rough landmark location for each. The computation was simpler than it may appear. Two points (the fourth and fifth) were specified. Four more were computed by solving four spherical triangles. Since the initial edge was on a meridian, these four could be reflected to four more on the other side of the meridian. This made ten, and their antipodes were the second ten, to complete the set. The required answers are: (1) the second point is in the Arctic Ocean on the Cambridge meridian 400 miles from the North Pole, and (2) only one point (that in Cambridge) falls in the U.S.

Also solved by Paul Burstein, John Crawford, Brian Forst, Peter Groot, Doug Hoylman, Bogdan Marcovici, Bruce Parker, Gilbert Shen, and the proposer, Karel Jan Bossart

**O/N4** Given a set of  $N$  elements arranged in a particular lineal order, rearrange the elements in a new lineal order to satisfy the following two conditions: (1) no element to be in its original position; and (2) no two elements which were originally consecutive (they may still be adjacent as long as their order is reversed).

Michael Sutherland says he "keeps thinking that there's something I'm missing in this problem," but here is his solution:

It would seem that, for  $N$  odd and greater than 3, the following procedure will satisfy the conditions:

- Remove the middle element.
- Reverse the order of the remaining elements.
- Place the removed element either first or last in the order.

The set  $\{1, 2, 3, 4, 5, 6, 7\}$  arranged thus: 1 2 3 4 5 6 7 can be rearranged thus: 7 6 5 3 2 1 4 and satisfy the conditions.

Also solved by 25 other readers: Ted

Longitude	Latitude	Location
W 4° 59' 43.75"	S 50° 50' 05.36"	In Atlantic, 400 mi. NW. of Bouvet Øya
W 34 24 36.11	N 14 09 56.65	In Atlantic, 700 mi. W. of Cape Verde Is.
W 47 55 42.01	S 24 50 41.27	Near Iguape, Brazil
W 71 05	N 42 22	In Cambridge, Mass.
W 71 05	N 84 10 37.15	In Arctic, 400 mi. S. of North Pole
W 94 14 17.99	S 24 50 41.27	In Pacific, 1,400 mi. SW. of Peru
W 107 45 23.89	N 14 09 56.65	In Pacific, 500 mi. SW. of Mexico
W 137 10 16.25	S 50 50 05.36	In middle of South Pacific
W 151 20 07.89	N 18 35 04.54	In Pacific, 200 mi. SW. of Hawaii
W 170 49 52.11	S 18 35 04.54	In Pacific, 50 mi. NW. of Niue Is.
E 175 00 16.25	N 50 50 05.36	In Pacific, 100 mi. S. of Buldir Is.
E 145 35 23.89	S 14 09 56.65	In Coral Sea near Cooktown, Australia
E 132 04 17.99	N 24 50 41.27	In Philippine Sea near Dalto Is.
E 108 55	S 42 22	In Indian Ocean 500 mi. SW. of Australia
E 108 55	S 84 10 37.15	In Antarctica, 400 mi. N. of South Pole
E 85 45 42.01	N 24 50 41.27	In India, near Gaya
E 72 14 36.11	S 14 09 56.65	In Indian Ocean 500 mi. S. of Diego Garcia Is.
E 42 49 43.75	N 50 50 05.36	In U.S.S.R. near Borisoglebsk
E 28 39 52.11	S 18 35 04.54	In Africa near Victoria Falls
E 9 10 07.89	N 18 35 04.54	In Africa near Agades

Altman, Peter Anderson, Allan Andersson, Gerald Blum, Richard Bumby, Edward Gershuny, Peter Groot, Walter Hausz, Dennis Hegler, Doug Hoylman, N. Judell, M. Kunstenaar, Judith Longyear, Roy McDonald, W. J. Mitchell, Bruce Parker, Harold Phinney, Robert Potash, R. Robinson Rowe, Donald Savage, G. S. Sacerdote, Steve Shalom, Gilbert Shen, J. Woolston, and Harry Zaremba.

**O/N5** In four tosses of a pair of dice, what are the odds against making a seven on the first throw and the point six on the second and fourth tosses without losing one's turn to roll?

There were a variety of answers, but Captain J. Woolston's looks right to me: If you can only lose your turn in making a point with 7, the odds against this particular sequence are:

$$1 - (1/6 \cdot 5/36 \cdot 25/36 \cdot 5/36) = 1 - 625/279,936 = 279,311/279,936.$$

Also solved by Ted Altman, Allen Andersson, Gerald Blum, Brian Frost, Peter Groot, Steve Krimbill, M. Kunstenaar, Tom Murphy, R. Robinson Rowe, Michael Sutherland, and the proposer, Harry Zaremba.

### Speed Department Answers

**SD1** The column totals lead to the equations:

$$S + E = 10$$

$$N + T = 9$$

$$I + T + U + 1 = M$$

With different digits for I, T, and U, M must be at least 7. To make MIT the greatest, try  $M = 9$ . This will make  $I + T + U = 8$ , with a choice between  $1 + 2 + 5$  and  $1 + 3 + 4$ . Again, to make MIT the greatest, choose the first, making  $I = 5$  and  $T = 2$ . Then from the second equation,  $N = 7$ . With 1, 2, 5, 7, and 9 assigned, the only digits left which will satisfy the first equation are 4 and 6. To decide which is S and which is E, the clue is in the lyrical symbol. If  $E = 4$  and  $S = 6$ , 42657 is deciphered as ETSIN, but the other choice,  $E = 6$  and  $S = 4$ , decipheres 42657 as STEIN of the Stein Song. Hence the summation is

5 7 4  
2 5 2  
1 2 6

9 5 2

**SD2** Here is one word (of many) in each case:

- |              |              |
|--------------|--------------|
| a. Newsstand | e. Recelpt   |
| b. Sycamore  | f. Indict    |
| c. Permit    | g. Persimmon |
| d. Subpoena  |              |

Alan J. Gottlieb teaches mathematics at North Adams State College; send solutions and new problems to him at the Department of Mathematics, North Adams State College, North Adams, Mass. 01247.

## Book Reviews

Continued from page 10

most offensive industries out of Moscow and impose some control on the remainder. There has been improvement. In 1962, the sulfur oxide readings were down to the Philadelphia level, though still worse than Cincinnati, and the particulate concentration had fallen by over half since 1956, though it was still higher than New York's. Tom Lehrer would be right at home. ("We'll all go together when we go.")

### Look at the Incentives

Mind you, there are plenty of laws. The Conservation Law of 1960 runs 10 closely-printed pages and the Water Law of 1970 is twice as long. One would even imagine that a centralized socialist

state would have an advantage over your average bourgeois democracy when it comes to getting laws passed. They run about neck and neck when it comes to enforcing them: not very well. The reason for this failure is the same in both places. No complicated modern socialist economy can be completely centralized, in the sense that not every decision can be made or policed by the supreme authority. Cabinet ministers, deputy associate assistant ministers, bureaucrats, and factory managers will all have something to do with what actually happens. So what actually happens will depend on their incentives.

If the cellulose factory manager has a plan to fulfil, with money or medals for over-fulfilling it, he or she will regard grinding out the cellulose as an objective of personal and social importance and will regard the health of the fish in Lake Baikal as the frivolous concern of environment freaks and the commercial fishermen who probably tend to be local yokels. Moreover, to a graduate of a course in cellulose engineering, cellulose will seem like one of the loveliest, most interesting materials on earth, much more interesting than fish. The boss will see it the same way; he will get his kicks from production, too. Moreover, he will have to compete for promotion with somebody who is running a bunch of cellulose plants in a different part of the country, on a different body of water, where there is no uproar about ecology.

In the nature of the case, the distribution of knowledge about the production of cellulose and attention to it is such that, in any bureaucratic infighting over enforcement of environmental directives, the advantage lies all with the factory manager and his immediate superiors. It's no wonder that the regulations face an uphill battle. If you think we in the United States are any better off, read the interesting article "Clean Rhetoric, Dirty Water" by A. Myrick Freeman and Robert H. Haveman in the Summer, 1972, issue of *The Public Interest*.

We may be better off in one respect, as Professor Goldman points out. One thing that does discourage the wasteful use of valuable natural resources is a high price for them. In a socialist society, land and natural resources are *par excellence* the property of "everybody." How can one charge the people for what is rightfully theirs? So land tends to be regarded as a free good, and builders haul away the sand and pebbles from the Black Sea beaches by the millions of cubic meters, and the removal of this buffer opens the way to extensive erosion by wave action.

### Taking the Tax Route?

There is a moral here for everyone, especially for us environment freaks, in both countries. Detailed regulation cannot cover every case unambiguously, so there will have to be negotiation. In the negotiation, the polluter will usually win a lot, if not everything. (Remember, the polluter feels virtuous, too.) It is likely to be far more effective to use the law to change incentives, and the price system offers a way to do that, through

the imposition of user charges, effluent taxes, and fees on those who use the environment to dispose of waste.

It won't be easy, because taxes can be eroded just as regulations can. But the tax route is easier to administer and puts the administering authority at less of an informational disadvantage compared with the operator on the ground. Think of the hassle over whether the automobile companies can or can't meet a particular set of emission standards by 1975. Suppose instead that the Congress had legislated a graduated tax on exhaust emissions to be paid by each car produced in 1975 according to its measured characteristics. The industry would fight like tigers, of course, and threaten higher prices (yes indeed) and unemployment (not necessarily). But the industry could hardly say that it can't possibly, because it can. And once the tax was on the books, the payoff to every automotive engineer and manager would shift to favor cleaner exhaust. Think about it.

## On Self-Defeating Prognostications

### Book Review:

Dennis L. Meadows  
Dartmouth College

### The Doomsday Syndrome

John Maddox

McGraw Hill Book Co., New York, 1972, x + 293 pp., \$6.95

How comforting it must be to live in the world of John Maddox. The problems which occupy the attention of many institutions and people in our world either do not exist in his world or need only marginal improvements in laws and technology for their solution. Population growth rates are falling in Maddox's world, and his less industrialised countries are about to emerge into a new age of abundance; the spectre of famine has finally been put to rout, and man's activities on earth are so inconsequential that there is no potential for serious disruption of the environment. The only serious problem in Maddox's world seems to be that an increasing number of individuals manifest the "doomsday syndrome."

Because there are no other serious problems in his world, Maddox has written a little tract describing the syndrome, listing its serious implications, identifying several who suffer from it, and indicating why it is inappropriate in his world.

Those suffering from the syndrome can be identified by several symptoms: no appreciation for the innate wisdom and flexibility of political institutions; a feeling that the course of modern technology does not serve the best interests of the globe's citizens; a tendency to emphasize the unity of the living world; a preoccupation with the analogy of the spaceship earth; an attitude that one should always be prepared for the worst; a certain disrespect for the science of economics;

"unseemly" interest in the problems of the poorer countries; a notion that industrial growth is not unmitigated good.

Those suffering from the disease, according to Maddox, are the cause for concern because they may alienate the poor countries from the West; their false warnings of catastrophe may distract us from short-term problems; and they may "undermine our spirit." Of course the less developed countries are already being alienated by the increasing gap in income which comes in part from our failure to take a long-term perspective. The current short-term problems have arisen in many cases from past efforts to ameliorate fundamental difficulties with short-term, stop-gap measures, and our social spirit is already being undermined by the recognition that fundamental problems are not being squarely faced.

There are very many fundamentally important and subtle issues implicit in the current environmental debate: for example, how should one most appropriately weigh the various costs and benefits of one's actions as they occur over time and in different geographical areas? What are the implications for the long-term health of our society of the fact that technology gives us new capabilities at a rate several times as fast as our social institutions and personal values can adapt? What is the appropriate basis for action when one's acts can lead irreversibly to many different consequences, each with near-zero likelihood of occurrence but near-infinite costs if they do occur? All of these are essentially ignored in *The Doomsday Syndrome*.

Instead, Maddox resorts to the same strategy he imputes to those he attacks: over-simplification and a selective use of data. His straw man is the individual who cries out at random intervals that the world and all that goes with it are totally and irretrievably doomed. Little matter that a close reading of even the early environmental literature provides no real example of such an individual. Maddox makes him and his ilk the subject of a 250-page monologue.

Less important than Maddox's explicit statements are the two cardinal assumptions implicit in this argument. He assumes that men's activities are so in-

significant compared with natural processes that there is no foreseeable possibility of disrupting the natural environment. He also assumes that the delays in our political and natural systems are so short that we can correct every problem after it becomes apparent. Neither of these assumptions is true.

A preparatory study for the Stockholm conference, *Man's Impact on the Global Environment*, cites 12 instances in which the flow of material through the environment resulting from men's activities already exceeds that from natural processes, and the current trends are for the annual release of material pollutant to double within the next 15 years. We have already entered into that phase of man's evolution where the natural system can no longer be counted upon to accommodate any foreseeable level of industrial activity.

There are very long delays in all aspects of our social and economic system. Population would finally stabilize only 70 years after family size falls to two children per couple. It will take us many decades to finally assess the meteorological implication of current pollutant emission. Prices, the primary instrument for bringing reallocation, change only after society perceives that new costs must be attributed to particular activities.

Thus society must adopt a long-term perspective. If many early efforts to see the potential consequences of current activities have resulted in pessimistic projections, it is only because mankind does harbor the seeds for its own destruction. To focus only on the environmentalists without looking at the statements of those who initially opposed them is misleading.

Rachael Carson did say strong things about pesticides but she in turn was vilified by many interests who were selling agricultural chemicals as a solution to all man's problems and who completely denied the possibility of any harmful side effects. It is unfair to take Ehrlich's first statements on population out of their social context. The early 1960s saw many pronatalists as strident as any of the environmentalists' statements that Maddox denounces. It appears relevant to remark here that it was in large measure the work of those Maddox criticizes which led to our current phase of more recent environmental concern.

The problems which confront us are proof enough that society's path of evolution is not automatically optimal. For the first time we are trying to anticipate the ultimate consequences of current action and working to minimize the probability of the less desirable outcome. To call society's attention to the fact that very serious consequences could come from current actions would seem to be the best way of ensuring that those consequences are not realized. To claim that there are no long-term problems and that a short-term perspective is sufficient, would seem, on the other hand, to be a self-defeating prophecy.

*This review is excerpted from a longer essay by Professor Meadows in the Manchester Guardian Weekly for June 1, 1972. Reprinted by permission.*

## To a Computer Writing Verses

Colleague machine, on unshared time,  
draft after draft ticking off unstuck,  
deep through the night we both of us  
rhyme,  
seeking to slip through sense to luck.

"Not in Montaigne, but in myself  
I find the faults I see in him."  
Down in each Ghibelline dwells a Gueff.  
The devils themselves were Cherubim.

Play with the language, Joyce's Christ!  
lifting the feet, laying them down,  
fed upon Rilke finely diced;  
verb, article, adjective, noun.

Reprinted from *Something Human* by Barry Spacks (Associate Professor of Literature, M.I.T.). New York: Harper's Magazine Press, 1972 (\$6). Copyright 1972 by Barry Spacks.

# GREAT REVIEWS FOR A GREAT PROFESSIONAL BOOK...



## ELECTRONIC FLASH, STROBE

By Harold E.  
Edgerton

384 pages, illustrated

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# Institute Review

## **\$6 Million for a Center for Cancer Research—Fundamental Studies, Not a Crash Program**

"Cancer research is not ready for a crash-program approach."

Hardly a surprising statement, except that it comes from a man just beginning the task of organizing and operating a major new Center for Cancer Research at M.I.T., with funding that may total as much as \$6 million by the end of 1976.

In fact, says Dr. Salvador E. Luria, Sedgwick Professor of Biology who heads the new Center, M.I.T. is "committed to a long-term program." So the Center will devote itself to fundamental research and teaching—"a great deal of effort to training young people—physicians, Ph.D.s, and graduate students—in the field of cancer research."

Plans for the Center were announced at M.I.T. on December 4, when the National Cancer Institute reported the award of two grants for the purpose: \$2,362,500 to help provide facilities for the Center for Cancer Research, and \$136,376 for operating costs of the Center for the first preparatory year.

The National Cancer Institute made an additional commitment for \$1,891,000 of operating support for an additional three years (1973 through 1976), subject to the availability of funds. In announcing the plans, President Jerome B. Wiesner and Howard W. Johnson, Chairman of the M.I.T. Corporation, pledged the Institute to adding another \$1,800,000 toward construction costs.

The Center will occupy space (now commercially leased) in M.I.T.'s Ford Building; renovations have begun, with preliminary occupancy scheduled by October, 1973, and full occupancy by May, 1974. In all, there will be 35,000 sq. ft. of office and research space.

In addition to Dr. Luria, the Center will have 12 research workers of faculty rank (of whom one or two will be persons already affiliated with M.I.T.), eventually about 60 professional staff members and technical assistants, and a total work force of about 150; the group will include some 10 graduate students. Faculty appointees will receive dual appointments—to the Center and to the M.I.T. department of their specialty.

Dr. Luria thinks the Institute's long history of pioneering work in biology and particularly in studies relevant to the can-

cer problem was instrumental in the National Cancer Institute's decision to develop the Center at M.I.T. He cites that "on-going commitment" as providing "the base upon which to build the Center—strong research groups in biology, chemistry and biochemistry, close ties with clinical centers working with cancer patients, and a reputation for excellence in research that will attract brilliant young researchers eager to search for solutions to the problem of cancer."

The emphasis on basic research is obvious in Professor Luria's plans for the Center. Its work will center on a number of research problems at the molecular biology level, dividing the work into four major areas—virus research, cell biology, immunology, and cell development.

No clinical studies are being planned at the Center for at least the first three to five years of its operation. But it will have a clinical advisory committee to keep workers informed of recent clinical developments and to propose clinical uses for basic research findings.

Dr. Luria shared the 1969 Nobel Prize for Medicine of Physiology for basic re-

search on viruses with Dr. Max Delbrück of California Institute of Technology and Dr. Alfred D. Hershey of the Carnegie Institution of Washington; he had come to M.I.T. as Professor of Microbiology 10 years earlier, and in that decade had helped establish M.I.T.'s reputation as a center of research in molecular biology.

A native of Italy, Dr. Luria came to the U.S. after studies at the University of Turin Medical School (M.D. 1935) and research at the University of Rome and the Institut Pasteur and Curie Laboratory in Paris. Between 1940 and 1959 he was associated with a number of American universities in teaching, research, and lectureship assignments.

## **Energy: How to Move Academic Research Into the World's Big Problems**

The energy crisis—real or fictional, present or future (see page 57)—is composed of equal parts of resources, economics, and technology. It affects every resident of the U.S.—even of the world.

Given a problem of such dimensions,



*Dr. Salvador E. Luria, Sedgwick Professor of Biology, is happily ensnared in a new assignment: to develop the research and management programs for a new Center for Cancer Research which may have as much as \$6 million to spend before*

*1976. It will concentrate on basic research in cell biology—a long-range program with an extensive commitment to training teaching, not a "crash-program approach." (Photo: Marc PoKempner)*



*As Director of M.I.T.'s Energy Laboratory, David C. White, Ford Professor of Engineering, will run an interdisciplinary enterprise patterned after the Lincoln and Draper Laboratories. Its goal will be to couple energy-related research underway in M.I.T. academic groups and supplement it with work by a full-time professional staff.*

how can a single institution contribute its wisdom and skills?

The answer for M.I.T., says Albert G. Hill, M.I.T.'s Vice President for Research, is an interdisciplinary special laboratory on the model of the Lincoln and Draper Laboratories. Its goal would be to help fund departmental research on energy problems and to add "a broad capability to undertake technology assessments, advisory functions, new prototype development, environmental evaluations, resource analysis, utilization evaluation and other studies." Together, he said, such work will "integrate the economic, environmental, ecological, and engineering aspects with the societal and policy issues involved in maintaining the nation's energy supply, demand, and utilization system."

To tackle that mouthful, Dr. Hill has tapped David C. White, Ford Professor of Engineering, to become Director of an Energy Laboratory.

Professor White starts with the assignment of tying together some \$5 million of energy-related research already in progress on the campus, and Dr. Hill thinks the Energy Laboratory may "fairly soon" reach perhaps a quarter of the size of its Draper or Lincoln prototypes, whose annual research expenditures by 1,400 employees are some \$50 to \$60 million each.

The Energy Laboratory's first new grant is a \$100,000 program sponsored by the New England Electric System to support research into new equipment, techniques and methods of supplying electric power. Under its terms, Harold Lurie, Director of Research and Development for New England Electric, will work with Professor

White on some Energy Laboratory problems.

Professor White, who with Professor Edward A. Mason, Head of the M.I.T. Department of Nuclear Engineering, generated the prospectus for the Energy Laboratory, is at present engaged in a major computer-based analysis of world-wide energy consumption and supply. He has been at M.I.T. since 1952, following graduation from Stanford, and he became Ford Professor in 1962—one year after he received the American Society for Engineering Education's George Westinghouse Award.

Professor Mason is a long-time leader in the design and development of nuclear power plants.

Dr. Hill, in his announcement of plans for the Energy Laboratory, speculated that it would be located "on or near" the M.I.T. campus, but he added that "its work might eventually require opening field offices elsewhere." A full-time professional staff to supplement student and faculty participation is planned. The Energy Laboratory will have associate directors and advisory committees for various functional divisions; an interdisciplinary committee of faculty, staff, and students to assure educational involvement of the Laboratory and educational use of its facilities; and an advisory board representing government agencies and the general public as well as M.I.T. administration, faculty, staff, and students.

One of the first proposals before the Energy Laboratory illustrates the problems confronting an educational institution wanting to develop work in this field. Some 14 M.I.T. faculty members in five separate disciplines want to assess the feasibility of combined gas-turbine-steam-turbine power plants—systems in which the hot exhaust gases from a gas-turbine-powered generator would be used to drive a conventional steam-powered generator. Theory suggests a total energy conversion efficiency of about 50 per cent for such a system, Professor White says, compared with the 40 per cent efficiency of present steam turbine plants.

To work out how this combined system might be attained will require basic studies in heat transfer, thermodynamics, combustion, and electromagnetics, followed in due course by engineering research and finally by pilot-scale models. The engineering involved must be done at a large enough scale to assure useful data, and pilot models are big, expensive, and highly specialized. At what stage do operations such as these become simply beyond the scope of any academic institution?

### **ABC Television: Solving Problems Born of Technology**

Television has shown astronauts touring the moon, but can it also show how science and technology can serve man on earth and help solve today's problems? And what about tomorrow's?

With the help of M.I.T., ABC News has undertaken to answer those questions by producing for network broadcast a series of half-hour programs entitled "What About Tomorrow?"

The first of the programs, dealing with

communication between man and machines, was presented in January. The second, with the sub-title "Cities: Our Next Frontier," will be broadcast at 6:30 p.m. E.S.T. on Saturday, February 10. Four others will be scheduled for succeeding months. Jules Bergman, ABC Science Editor, is narrator.

The series is the result of an agreement between President Jerome B. Wiesner and Elmer W. Lower, President of ABC News, but the story of how this came about goes back more than a decade. In connection with M.I.T.'s Centennial celebration, CBS presented three one-hour programs. The producer was Thomas H. Wolf. The first of the programs, titled "The Thinking Machine," was an exploration of new developments in computers and human psychology. Dr. Wiesner, then director of the Research Laboratory of Electronics, served as a sort of interlocutor.

In due course Mr. Wolf became Vice President and Director of Documentaries at ABC News, and after Dr. Wiesner became President of M.I.T. he suggested that it was time for television to have another look at science and technology through M.I.T. eyes.

President Wiesner asked Walter A. Rosenblith, M.I.T. Provost, to take charge of the planning for the Institute and James Benjamin, an ABC staff member with a strong academic background, was assigned as Executive Producer for the series. Shell Oil Co. agreed to become the sponsor.

The unifying theme of "The Thinking Machine" was the question "Can computers think?"—a question still not answered to everyone's satisfaction because it depends on the definition of the word "think." But since 1960, computers have unquestionably grown smarter. The first program in the ABC series told something about artificial intelligence and how men may better communicate with computers—even learn from them. The second program in the ABC series will emphasize the ways in which technology is being used to find solutions to urban problems. It will describe, for example:

□ Richard C. Larson, Associate Professor of Electrical Engineering and of Urban Studies, helping the Boston police use a computer for such purposes as effectively deploying patrolmen.

□ Frank S. Jones, Ford Professor of Urban Affairs, assisting the Columbus Avenue Tenants Association to rehabilitate a run-down apartment house in Boston's South End. (The building was scheduled for demolition by the Boston Redevelopment Authority, but it is structurally sound and the people who live there are convinced that with professional help from M.I.T. they can modernize their low-cost quarters for less than the government can build new housing.)

□ How in Lynn, Mass., where health facilities were underused because good transportation was lacking, a Dial-a-Ride bus system devised at M.I.T. is now delivering 150 people a day to clinics.

The third program, at 10:00 p.m. E.S.T. on March 16, will depict progress in medical research and health care delivery, an area of special emphasis at M.I.T. in re-



When he began to explore the M.I.T. campus as the scene for "What About Tomorrow?", producer James Benjamin found Calder's "Great Sail," and he decided to use it—instead of the Great Dome—as the show's M.I.T. "trademark." So the opening scene was shot (top) with Andre R. Jaglom, '74, Eve J. Higginbotham, '75, and Lee D. Giguere, '73 (right), striding toward the camera under the "sail." But it didn't make the show: Miss Higginbotham and Mr. Giguere are engrossed in a slide rule, and—as Mr. Benjamin learned quickly enough—M.I.T. students don't use slide rules any more. At the left (center), Jon Wilkman, producer of the first show in the series, is shown working with Terry A. Winograd, Ph.D.'70 (left), Assistant Professor of Electrical Engineering, on the artificial intelligence sequence. The picture at the bottom will be in the second show on February 10: Richard C. Larson, '65, Associate Professor of Urban Studies and of Electrical Engineering, at Boston Police Headquarters (where M.I.T. is helping with a computer system) with Sgt. William F. Bulger and Kirn W. Vogel of Urban Sciences, Inc. (Photos: Marc PoKempner and Wide World from Shell)

cent years. The fourth will tell about basic scientific research and the great unknowns which remain. A fifth program will describe the consequences of technological advance and man's efforts to modify them—what policy decisions should be considered in the attempt to avoid the bad and achieve the good. The subject of the sixth program remains to be selected.

After several weeks of work at M.I.T., Mr. Benjamin told *The Tech* that, though the series would concentrate on "questions being asked in fields where the public has concerns," few solutions would be obvious. "The kind of questions the layman asks are broad and foreclose answers." If there is a theme for the series, he said, perhaps it is that "not less but more science and technology will be needed to solve problems."

Professor Rosenblith is uncompromising when he discusses "the one idea that we hope will be projected through all of the programs." That idea is that "science and technology have a vast capacity to change the world. A deeper public understanding of science and technology today is necessary if we are to solve the problems that an improvident use of science and technology may create."—F. E. Wylie

(More than a week after the first program, the offer of further information from "Room 100, M.I.T." had drawn some 200 letters. Half of them were from schools wanting video-tapes.—Ed.)

### The Conflict Between Self-Reliance and a Profession

Like insects in a spider's web, are M.I.T. students and faculty alike "helplessly caught in the standard institutionalized style of encounter" simply because they sense no other way to act their roles?

Robert L. Halfman, '44, Professor of Aeronautics and Astronautics and Deputy Head of the Department, fears so. And in the next two years, with a half-time appointment as Visiting Associate Dean for Counseling in the Office of the Dean for Student Affairs, he hopes he may be able to influence the Institute toward experiment and informality in the educational process.

In a paper on "Perspectives on Education at M.I.T." written last summer, Professor Halfman noted a basic conflict between the Institute's views of higher education and that of many of its students. To the students, he said, the college years must be a time of that subtle shift "from a reliance on outside authority to an inner self-reliance" which is associated with maturity. But at M.I.T., the faculty's expectation is that students will "develop professional skills and competences," which is in a sense a process of learning reliance instead of dissociating from it.

The result is that students receive "mixed messages," he writes. "There are vague promises of scope for creativity, judgment, scientific thought, professional integrity and ethics conflicting with daily exercises in finding the 'right answers'."

Two goals for M.I.T.'s future educational efforts:

□ "Consciously and purposefully chal-

lunge the students' ideas of knowledge and values by confronting them with diversity and ambiguity," despite "strong counterpressures to teach specific professional skills and competences."

□ Promote collaborative learning, closer student-faculty contacts, and "move strongly to put pervasive competition and its supporting grading and valuing structures" into a secondary role.

Professor Halfman's appointment is the first in what Dr. Carola Eisenberg, Dean for Student Affairs, hopes will be a series designed to improve interaction between the faculty and the Dean's office.

## Taxes: When Should a University Pay, and How Much?

A total of \$345,000 has been paid to Cambridge by M.I.T.—more, apparently, than the city expected—as a contribution in lieu of taxes on M.I.T.'s tax-exempt campus properties.

Earlier this year the Cambridge City Council had suggested a formula of five cents per sq.ft.—based on a ratio of tax-exempt land of an institution to the city's total land area—by which all Cambridge schools and colleges might judge their obligations to the city in lieu of taxes. President Jerome B. Wiesner said that the formula yielded what in M.I.T.'s case seemed to be essentially fair; but the Institute decided instead to make its payment on the basis of the same considerations by which its similar payments had been determined in prior years.

"In making this year's contribution freely and voluntarily," said Dr. Wiesner, "M.I.T. reasserts its belief in the principle of tax exemption for educational institutions. It is convinced that this policy is wise and of great benefit to society.

"While determined to protect and maintain its lawful tax exemption, the Institute

also accepts—as it has for many years—its civic obligation to make an in-lieu-of-tax contribution to Cambridge."

In addition to the \$345,000 payment in lieu of taxes, M.I.T. paid some \$1.8 million to Cambridge in 1972 as taxes on its taxable property. Over the past five years the Institute's payments to Cambridge in taxes and in-lieu-of-tax contributions have totalled over \$8.9 million.

## From School to Job— It Used to be . . .

. . . simple. But it's not any more, thinks Howard W. Johnson, Chairman of the M.I.T. Corporation, and he wonders if we cannot somehow restore "the established ritual of bringing youth into adulthood."

The subject came up between Mr. Johnson and a reporter for the *Quincy Patriot-Ledger* following Mr. Johnson's address to a banquet of the Institute of Food Technologists, Sections East, last fall. In it, Mr. Johnson cited "today's alienated young people" as one of three examples of contemporary problems that exist "because of the failure of strategically placed individuals to take the longer view in the past."

What he meant, Mr. Johnson told the *Patriot-Ledger*, was that parents in the distant past used to help their children in the transition from school to work. Now the tradition of sons working with their fathers in the family trade or on the family farm is gone, and there's nothing to replace it for many high school students.

"We do many things for our youth but not the one indispensable central thing: getting them from school to work in an effective way," Mr. Johnson said. "We simply turn them loose without preparing them for adulthood."

"More primitive societies may not have our sophistication in many ways," he continued, "but they have one thing we have lost. They have a great sense of the steps that must be taken to maintain a stable society . . . and they take them." The "established ritual of bringing youth into adulthood," he said, was one of these.

Mr. Johnson's suggestion: cooperative programs alternating school and work periods adopted at the high school level. Then high school students would have some real idea of the world which awaits them upon graduation, and high schools might not need the placement bureaus to help young people make the transition from study to work which most of them do not yet have.

## Remember the Division for Educational Research?

No? You're not alone. Hence a bit of history:

The Commission on M.I.T. Education (1969-71) said undergraduate education "is not as coherent or as personal as it ought to be," and its members recommended a new First Division "as an institutional focus for innovation in the first two years," and within it an Experimental Section "to encourage faculty members to develop and initiate new programs of instruction."

Studying these recommendations, a faculty task force (1971) under Hartley Rogers, Jr., Professor of Mathematics who is now Chairman of the Faculty, said that M.I.T. should have a Division for Educational Research as "a framework for mounting interdisciplinary efforts in educational research."

Now President Jerome B. Wiesner has appointed a Steering Committee "to develop an Education Division at M.I.T. and to help shape the Division's initial policy." Its Chairman is William T. Martin, Professor of Mathematics, who was Professor Rogers' predecessor as Chairman of the Faculty.

President Wiesner's announcement anticipated a series of related—and potentially highly significant—activities for the Education Division:

□ Giving faculty and students opportunities to work together on "some of the fundamental dynamics of the educational enterprise."

□ Bringing together faculty and students for research on educational problems.

□ Offering undergraduate and graduate classes.

□ Developing a cadre of faculty and students of its own, in addition to those it shares with traditional academic departments, if necessary and as needed to accomplish its goals.

A hint of the possibilities also comes from the list of four subcommittees named to work under the Steering Committee; the chairmen are in parentheses:

□ Human sciences subcommittee, to study concepts and techniques from the social sciences appropriate to the Division's research and teaching (Dr. Benson R. Snyder, Dean for Institute Relations).

□ Education technology subcommittee, to see how the Division may foster educational uses of such new technology as video tapes, television, film, and computers (Professor Wilbur B. Davenport, Jr., Sc.D.'50, Director of the Center for Advanced Engineering Studies).

□ Academic programs and students—an assignment considered self-explanatory (Professor Martin).

□ Colloquium subcommittee, to arrange for this year a series of lectures on educational organization, educational technology, physiological and psychological inputs to education, and other relevant topics (Lotte Bailyn, Associate Professor of Organizational Psychology and Management).

Members of the Steering Committee, in addition to subcommittee chairmen, include Richard M. Held, Professor of Experimental Psychology; Seymour Papert, Professor of Mathematics and Co-Director of the Artificial Intelligence Laboratory; Professor Rogers; Donald A. Schon, Professor of Urban Planning; and Jerrold R. Zacharias, Professor Emeritus of Physics who is Director of the Education Research Center. The Steering Committee reports to Walter A. Rosenblith, Provost, who is an ex-officio member.

## "Higher Education Faces a Greater Crisis Today Than Ever Before . . ."

That's a quotation from Robert C. Wood, President of the University of Massa-



The smiling faces at the left are those of Frederick J. Reardon (left), Cambridge Collector of Taxes, and John H. Corcoran, City Manager. They're receiving M.I.T.'s checks for more than \$201,108—payments in lieu of 1972 taxes to the City—from Kimball Valentine, Jr., Assistant Treasurer of the Institute.

achusetts, speaking last fall at the M.I.T. Club of Boston.

The crisis about which he is talking may not be the one you expected; it's the crisis of productivity. "What are our educational institutions producing?" is a key question today," said President Wood, "and right along with that is the question, 'What should they be producing?'"

Answering members' questions, he offered some examples of what he meant. "There are many problems to be worked out in all new educational plans. I think it is especially appropriate to mention this here, because M.I.T. has been pioneering in various methods of handling the freshman year and has discovered that evaluating the programs is usually much harder than setting them up."

Increasing productivity and efficiency of education while retaining personal touches, said President Wood, "is one of the toughest internal management problems we face."

### Hosting the Chinese: "I Think We'll See More of Them"

What do you do when 10 visiting scientists from the People's Republic of China walk into your office?

You shake hands and relax, says John M. Buchanan, Wilson Professor of Biochemistry at M.I.T.

Dr. Buchanan was one of several "guides" for members of a Chinese scientific delegation sponsored by the National Academy of Sciences during its M.I.T. visit on December 5. He told *The Tech* that the visitors' discussions in the Biology Department were "very lively" and that there was "great interaction" between the Chinese and their American hosts.

"There was extreme friendliness and a willingness to talk on all levels, and a lack of suspicion and fear which is often shown by visiting foreign scientists."

Victor F. Weisskopf, Head of the Department of Physics who was the official host to the delegation at M.I.T., agreed. He told *The Tech* that the Chinese were "unusually open people . . . and much less formal than foreign scientists usually are." He found it, he said, "a warm, personal, informal visit."

So did President Jerome B. Wiesner, who thinks the Chinese had "a very good visit in Boston." Joel Orlen, Assistant to the Provost, also said things went well; "I think we'll see more of them," he told M.I.T.'s Administrative Council.

There was no press conference at M.I.T. But on December 4, after the Chinese had spent the day at Harvard, David F. Salisbury of the *Christian Science Monitor* was told by Pei Shih-chang, the head of the delegation, that "we have found the American people and scientists share with us a desire to develop scientific resources."

### The Gentle Persuader: Confrontation Coming!

Someone once asked Anne E. Ellison if she had a staff job or a line job as Assistant to the Dean for Student Affairs.



Jerrold R. Zacharias, Director of the Education Research Center, had an unusual audience for a demonstration of some of the Center's work on December 5. Tsien Jen-yuan (left) and Li Fu-sheng were members of a 10-man delegation from the People's Republic of China touring the U.S. under auspices of the National Academy of Sciences. In Boston for more than three days, the visitors went to Lexington and Concord on December 3 before a welcoming dinner at the M.I.T.

She was confused, and asked for definitions. If you have a line position, she was told, you can direct people; if a staff position, you can only persuade them. Then the answer was clear; for Mrs. Ellison considers herself simply "a gentle persuader."

Who has the line job for women students at the Institute? The students and the alumnae.

Women at M.I.T. are now a big enough minority to be visible. But they cannot yet claim commitment from the Institute; for that the clamour must be louder: M.I.T. must be forced to choose—admit a woman *instead* of a man.

That is Mrs. Ellison's analysis, delivered this fall—Mrs. Ellison was then six weeks in her new job as a sort of women's advocate in the Dean's Office—to a meeting of the Association of M.I.T. Alumnae.

Signs of progress: the lot of women students at M.I.T. is improving. Better athletic facilities this year (and a physical education requirement). More women Educational Counselors to help encourage more women to apply. Action from the Association of Women Students: plans for a career day for New England high school students. More awareness everywhere of discrimination—and the potential for it. Indeed, Mrs. Ellison said, "M.I.T. treats women very equally."

But that's not enough. There simply aren't enough women on the campus—in high places, to serve as counselors and inspiration for students; as colleagues in classes, to assure that no woman has "special treatment" because of her sex, to avoid the "awkward social situations" which may seem ideal when you're a freshman but are a drag four years later.

Mrs. Ellison's answer—more women on the campus—means more applicants. Go

President's House that night, spent December 4 at Harvard and December 5 at the Institute. Their M.I.T. visit included the Departments of Biology, Chemical Engineering, and Physics, the National Magnet Laboratory, the Center for Space Research, and the Parsons Laboratory for Water Resources and Hydrodynamics. The visitors' special interests turned out to include research in environmental protection, cancer, and computers.

beyond the present "token" group of 400 undergraduate coeds. Force M.I.T. into a real commitment by making the Admissions Committee displace a man in order to take a more qualified woman. It hasn't come to that—yet.

When M.I.T. faces that problem, says Mrs. Ellison, then it will truly confront the issue of its commitment to women.

Are there really so many girls in high schools who ought to come to M.I.T.? Surely there are; men have no exclusive adroitness in quantitative thinking, and the demand for top-notch college admissions is higher among women than men. The trouble is that M.I.T.'s present approach is "pretty subtle."

### The XXVth Roman Numeral: How to Study All Science at Once

Course XXV appeared with little fanfare in the M.I.T. Catalog this summer—an interdisciplinary program intended to help undergraduates meet special interests or simply study more different topics than is possible in any of the departmental curricula in the School of Science.

Course XXV is the only one in the Catalog not associated with a department; it is, instead, sponsored and operated by the School of Science, which recommends it as "a broad and flexible, interdisciplinary and coherent education in science."

But it is not intended for samplers; the Catalog says each student's curriculum "must include a strong and coherent set of science subjects," and it must be approved by a faculty adviser who is responsible to a faculty committee and ultimately to the Dean of the School of Science.

# "This Experience Usually Provides the Student with the Fortitude to Conduct Research . . ."

Though it evokes images of students as gladiators, this is how one department praised a four-year-old educational experiment.

U.R.O.P.—the Undergraduate Research Opportunities Program—seeks to bring to undergraduates the experience of conducting research. In 1972-73, more than one-third of M.I.T.'s undergraduates are participating.

In its first and second years, U.R.O.P.—funded at an annual level of about \$100,000, could offer students pass/fail units of academic credit for their work. Last year and this, with about \$200,000 annually, it could offer students a choice of pay or academic credit, and it has begun a program of summer employment so that students can continue for pay research efforts begun during the academic year.

The U.R.O.P. office, under the direction of Margaret L. A. MacVicar, '65 (or '64—she graduated a year early), Assistant Professor of Physics, asks M.I.T. faculty and, more recently, industrial and public service groups outside M.I.T., to provide research areas in which to bring undergraduates into their laboratories. These openings are compiled into a booklet which is sent out to students with their registration material each term. The Spring 1973 booklet runs to 116 pages. Additional opportunities are listed in *Tech Talk*, M.I.T.'s house organ, as they appear. (So popular are the listings that the U.R.O.P. office has to make special plans to cover its telephones on Wednesdays, when *Tech Talk* is published.)

At its beginning, U.R.O.P. requested from faculty members detailed descriptions of proposed research activities, but supported only about half of the proposed projects, feeling that other funding sources within academic departments might contribute to undergraduate research. With experience, the business of budgeting is conducted with greater efficiency, but it is not a bureaucratic tangle—money is handled with an informality that pleases many of the faculty who become involved in the program.

This year participation in U.R.O.P. is increasing but the budget will be down slightly, apparently because faculty members are increasingly willing to spend funds from their own grants to support their undergraduates.

*Technology Review* has spoken with people working with the U.R.O.P. program in three departments. Though the resulting account is impressionistic, perhaps it can communicate something of the caliber of undergraduates' contributions to research, when they succeed, something of how U.R.O.P. fits into some departments' commitments to undergraduate education, and something of the politics of acquiring support for research as well.

## I. The Architecture Machine

"The theoretical skeleton to architecture is pretty thin," according to Associate Professor Nicholas P. Negroponte, '66. "We don't know what makes people design; we don't know what makes good architecture." This has at least one happy result: The Architecture Department is not plagued by problems of how an education is to be divided between the theoretical and the practical. Design studios are the nuclei of the Department, analogous to project laboratories in some other departments, especially in that "a certain amount of fumbling goes on," typical of the reality of laboratory work.

Because the Department of Architecture by its nature embraces designing as an educational experience, U.R.O.P. immediately "fell into place." In the first year of the program, architecture was among its heaviest users. Last spring, 45 undergraduates participated.

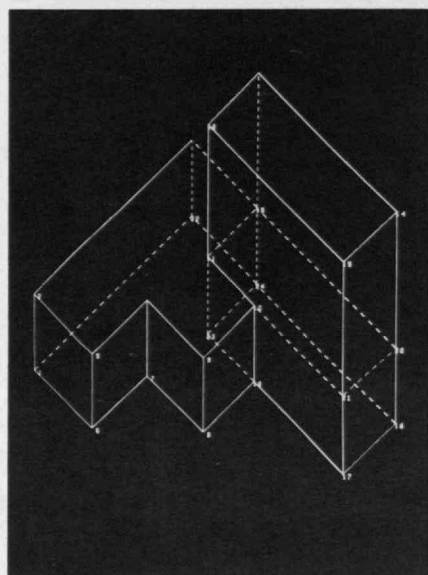
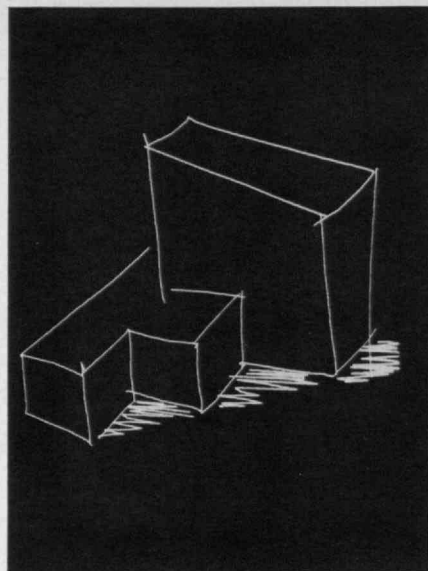
Professor Negroponte is the Department's U.R.O.P. coordinator. His own laboratory is known as the Architecture Machine Project, a room on the fifth floor of the Center for Advanced Engineering Studies, near the design studios on the fourth floor of Building Seven in the territory of the Architecture Department proper. The room is called simply the Machine Room. It houses the Architecture Machine, which has grown from a humble genesis four years ago to an imposing wall of electronics.

There are ten computers in or near the Machine Room. Four of them work and are part of the Architecture Machine. The lifeless hulks of the other six litter the laboratory, to be cannibalized as needed.

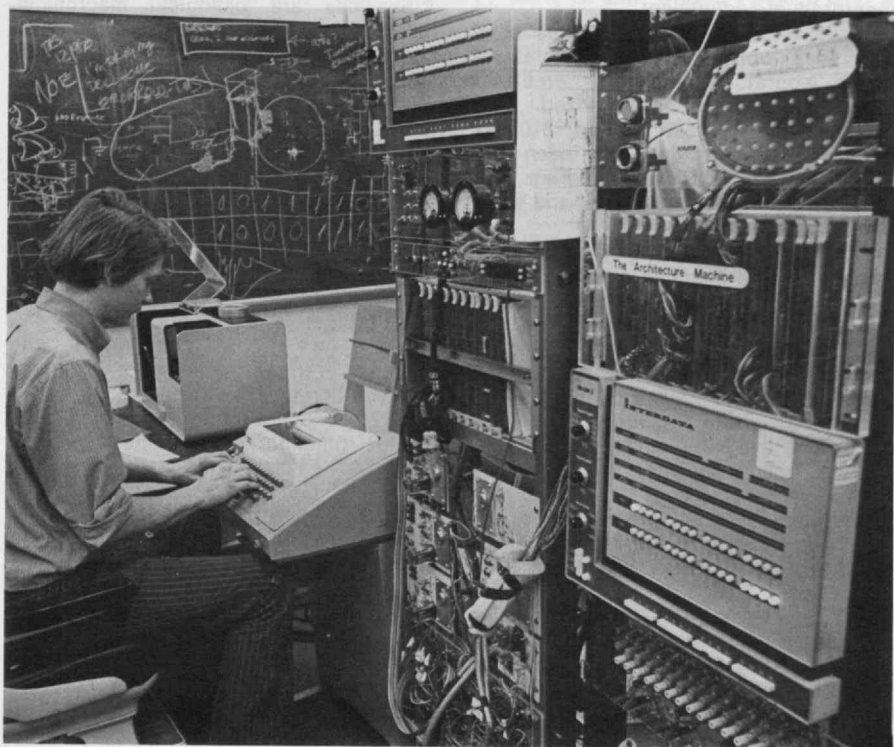
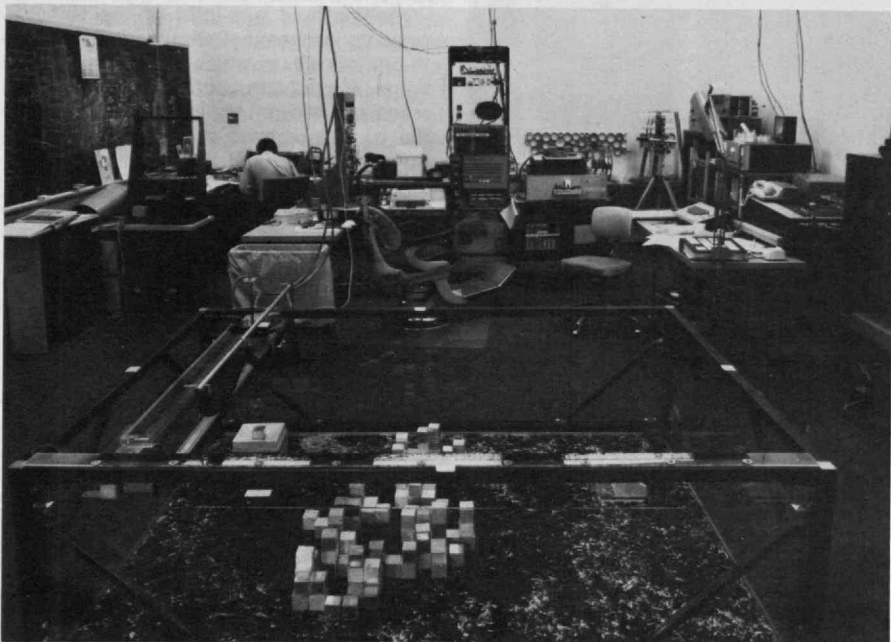
The Architecture Machine is not easily described. Its 241 banana plugs can accept inputs from sensing and measuring devices of all sorts mounted on a variety of devices that have included, at one time, a coffee pot. The Machine proper consists of the four working computers— analog processors with 32 kilobit memory and shared input/output.

The Architecture Machine can compile FORTRAN and other high-level languages. There is one high-speed printer, fast enough to be shared by the four computers; students have written all the software for that. Other outputs—16 in all—include plotters and cathode-ray-tube displays.

As each student's project advances, he graduates from a welter of connections to the banana plugs upward to a customized plug of his own. As the laboratory has grown, the rooms around it have become repositories for the projects of the past: on a shelf rests a mechanical arm with rows of inflatable tubes to simulate flexor and extensor muscles; elsewhere, in an office, is enshrined a toy tank with sensors on its under side which can explore a three-dimensional terrain as it travels.



The sketch at the top of this page is a hastily executed bit of geometry; below it is a computer's understanding of what the artist intended. The project is proceeding in the Architecture Department under a grant from the National Science Foundation. At right, a sequence of photographs shows the evolution of a lab where such research—and much other related work conducted by students in the Undergraduate Research Opportunities Program—is being done. The lab is called simply the Machine Room, and its computer system is The Architecture Machine. The top photograph shows the Machine near its beginning—and U.R.O.P.'s. To its left is a toy tank that can map the terrain it explores; sensors are mounted on its underside. The Architecture Machine grew as it became attached to successive projects. In the foreground of the middle photograph is a nation of gerbils; the Machine maps their environment as the gerbils move blocks around. The bottom photograph shows the Architecture Machine of a year ago, and the photograph on page 80 is a recent portrait.



U.R.O.P. has allowed Professor Negro-ponte to carry research beyond the limits imposed by research grants.

For example, the Project had a National Science Foundation grant to study sketch recognition—the use of a computer to take a designer's sketch, decide what the sketcher's intent was, and produce a cleaned-up, carefully delineated version.

The subject impinged on artificial intelligence research. In that field, computer programs have been written to search for important aspects in a drawing of a collection of geometric forms and, by analyzing aspects of the drawing considered to be important—especially certain sorts of vertices—"understand" the drawing sufficiently so that it can learn which lines belong to which forms and separate the individual figures. Children pick up these abilities in their early years.

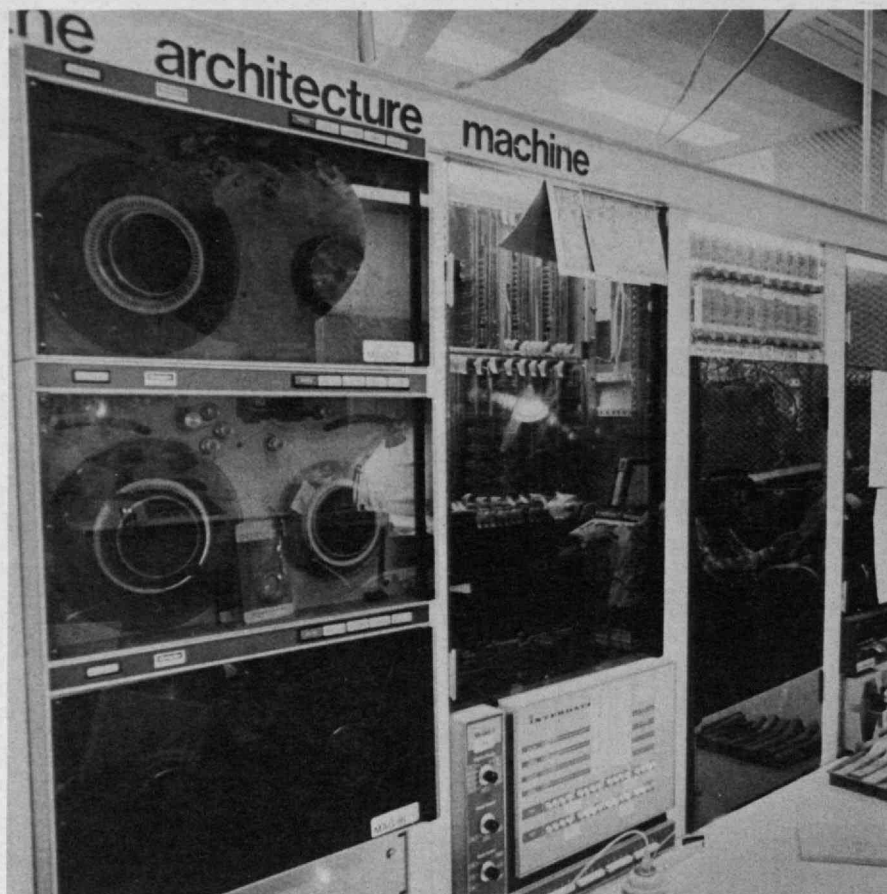
The N.S.F. grant provided funds for an effort to present to the computer two kinds of information as input: the drawing itself (done on a C.R.T. with an electronic pen) and the speed of drawing. Computer programs were to be written to use the speed with which the pen moved as a measure of the writer's intent; the drawing was likely to be executed at a slower rate at crucial points, faster elsewhere. It was apparent that the subject could be pursued down several speculative sidestreets where the N.S.F. might not be willing to invest its money. U.R.O.P. could provide the support for undergraduates to explore these sidestreets.

One student decided to measure galvanic skin response (changes in skin resistance to current flow—one of the measurements made by a lie detector) to see if that would be useful to a computer in determining purposefulness. It was not.

But another U.R.O.P. student decided to design a pen that would provide the computer with a measurement of pressure as a person wrote or drew on the CRT. That proved fruitful indeed. Work is now progressing on a computer program that will use writing pressure to help the computer recognize signatures. A second U.R.O.P. project will attempt to use stride and pressure measurements to identify people going through a doorway.

"Even though the dead-end rate is high," says Professor Negro-ponte, "you have a ratio of one in four projects that become very important." Offshoots of sponsored research, they show the way to new fields for which research support can be sought.

One U.R.O.P. project was a rather playful one; started in 1969, it has found its way to the Jewish Museum in New York. A community of gerbils live in an environment of 500 blocks. A computer knows the gerbils' world, but the gerbils often rearrange it as they move blocks about, intentionally or by accident. The computer is programmed to keep track of the gerbils' world, so that each block can be restored to its proper place—unless the block has been moved sufficiently so that the computer decides that the gerbils have made the modification on purpose and want it left that way. In that case, the computer's model of the



world changes.

Several engineering undergraduates have gravitated to the Architecture Machine to work with the enormous inventory of hardware, or write software systems for it. They must make their work useful and dependable, for it will be used by others at the laboratory—an experience that is “pretty intriguing to an undergraduate.”

The laboratory now has three or four research projects and nine or ten staff members—graduate student research assistants whose education is supported in this way. All of these graduate students came to the laboratory as undergraduates who participated in the U.R.O.P. program, and it is through U.R.O.P. that Professor Negroponete came to know all of them. “To me,” he says, “The most valuable part of U.R.O.P. is a way of getting to know on a very intimate basis students who are interested in research.”

## II. An Enzyme-Catalyzed Reaction

Chemical engineering has always had project laboratories and the Practice School, and the Department still requires an undergraduate thesis.

U.R.O.P. was consistent with all that, though it had a slightly different sort of organization. In chemical engineering U.R.O.P. is providing a way for undergraduates to work in laboratories, in groups with faculty, or singly with graduate students. “A surprisingly large fraction of the department has participated,” thinks Clark K. Colton, Ph.D.’69, Assistant Professor of Chemical Engineering, who is probably the Department’s most active faculty participant in the program. At

least 40 per cent of the faculty have participated at one time or another. He himself is interested “not only in the educational process itself, but in the help that undergraduates can under certain circumstances give to research.”

A proposal for National Science Foundation funding for U.R.O.P. activities during the coming summer shows the effect U.R.O.P. has had on the Chemical Engineering Department’s commitment to undergraduate education:

“About 15 to 20 undergraduates each term have worked in departmental research laboratories for either credit or pay,” the proposal summarized. Last Year’s program cost “about \$10,000, 60 per cent of which has been defrayed by the U.R.O.P. program and the remainder by departmental and grant funds.”

Last summer, in an experimental program, the Department of Chemical Engineering hired 14 undergraduates for the summer at a total cost of \$16,000, of which U.R.O.P. provided about \$5,000; the rest came from departmental and grant funds. The Department says the experience “was judged extremely worthwhile by participating faculty and students, many of whom continued on their projects in the fall.” Now it proposes to the National Science Foundation that funds be provided to hire 29 undergraduates for 12 weeks during the summer of 1973; each of them, says the proposal, “will be expected to carry out his described plan of attack. . . . The student with advice from faculty will be expected to overcome the experimental difficulties and yet achieve his research goals. This experience usually provides

the student with the fortitude to conduct research. . . .”

Professor Colton recalls that U.R.O.P. funding was a big help a year ago, when “seed money” was needed while a request for funding was under consideration by the N.S.F. Why then must work stop until the paperwork was over? Interim funding was needed; the proposal in fact languished in red tape from October until the following June.

In times like those, a small amount of money could keep things going; U.R.O.P. provided that money. But one laboratory overspent; U.R.O.P. quietly picked up part of the overrun; the Department picked up part, and a small grant appeared. Then the proposal was approved, and research went smoothly forward. “Surprisingly small amounts can be exceedingly valuable when there is nothing else,” says Professor Colton.

One-fourth to one-third of the U.R.O.P. projects in chemical engineering are one-to-one efforts, in which an undergraduate helps a graduate student in performing research relevant to the grad student’s thesis. The rest are projects in a laboratory, where there is almost always someone around who can answer questions.

Only the exceptional student proves able to work on his own from the outset; typically, a student needs a first term to “get acclimatized, get his feet wet. . . . Students who’ve been around longer become more proficient, and I think their motivation has increased.”

Professor Colton concludes from two years’ experience that only certain projects and certain graduate student sponsors can succeed with U.R.O.P. The chemical engineering graduate student who builds his own experimental apparatus and suspects that no one else is capable of running it as well is not likely to be a good U.R.O.P. senior partner. But a project in Professor Colton’s own laboratory seems to have had all the right ingredients.

“Enzymes are biological macromolecules which act as highly specific, exceedingly active catalysts,” wrote Professor Colton in a description of his work for U.R.O.P. “They show considerable promise in a wide range of applications, including analytical techniques, medical therapy, and as catalysts for industrially and socially important processes.” An example of this last, under investigation in Professor Colton’s laboratory is related to “the synthesis of an antibiotic from amino acids as raw materials.” The total project is a large one; it is being carried out in conjunction with members of the Departments of Chemistry and Nutrition and Food Science.

Thermodynamics is against the chemist in this reaction. The synthesis cannot take place by itself, but must be coupled with a “degradation reaction,” provided by nature: the degradation of ATP to AMP (the triple phosphate bond in ATP stores energy in muscles). An enzymatic route to the regeneration of ATP is the object of U.R.O.P. research. One enzymatically catalyzed reaction seemed to be an excellent possibility.

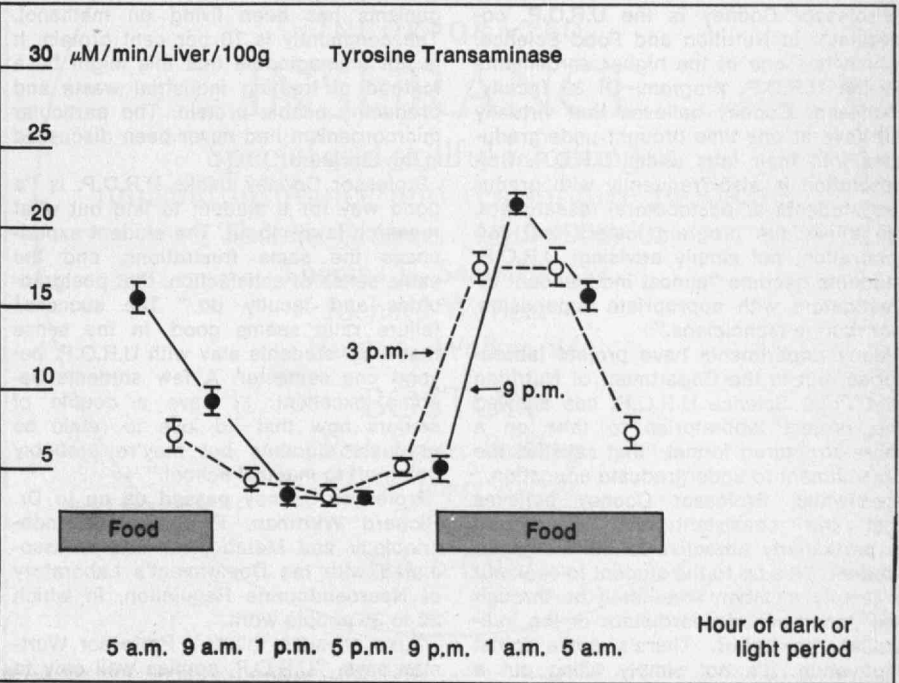
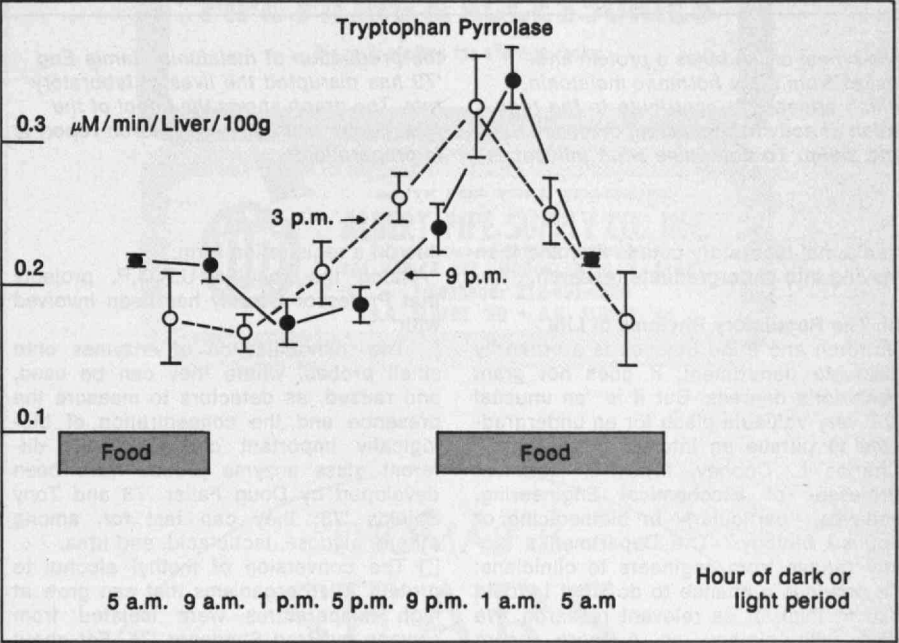
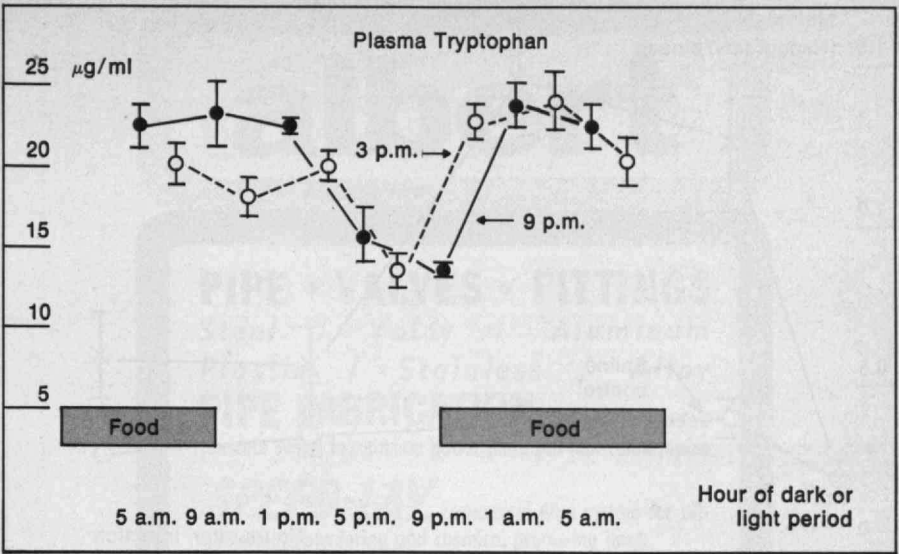
As part of the department’s U.R.O.P. program, four undergraduates were hired by Professor Colton last summer. Once

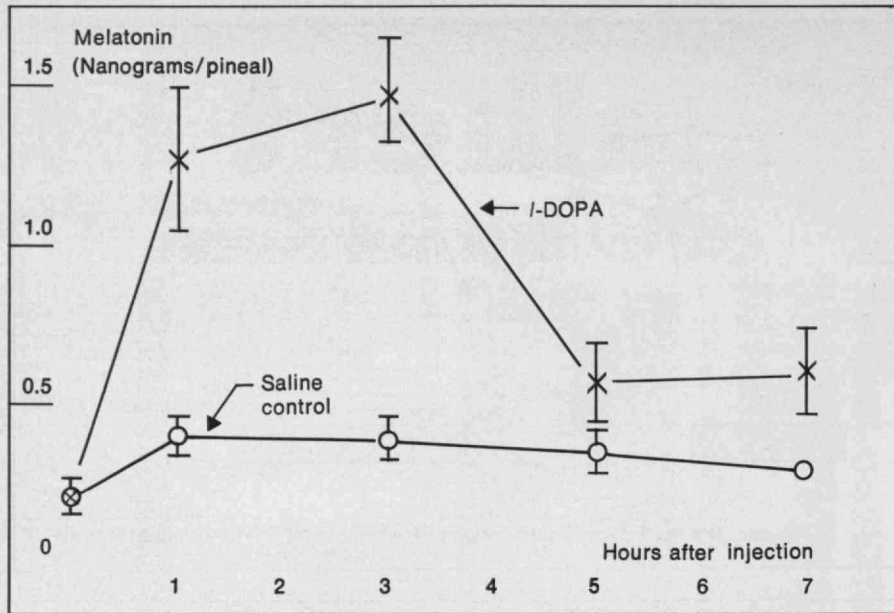
assay techniques to measure the concentrations of the chemicals involved had been developed, two students began to study the thermodynamics of the reaction. The third studied the stability of an enzyme that catalyzed the reaction. The fourth studied an adsorption method of separating one reactant from the final reaction mixture. Projects on such additional related matters as immobilizing the enzyme on solid supports so it does not contaminate the reactants are continuing. Professor Colton credits graduate students Robert Langer and Bruce Hamilton, and Research Associate Colin Gardner with "providing the kind of atmosphere in which this U.R.O.P. project succeeded."

Professor Colton estimates that "maybe one in seven" students do not succeed in U.R.O.P., in the sense that "they never get the hang of experimental work." But "twice as many as that are spectacular successes": they demonstrate an ability to conduct research and get results. For example, Martin Greenwald, working with others, demonstrated the feasibility of an ATP regeneration scheme, and his data was of a publishable quality, though not quantity.

The remainder of the U.R.O.P. students' achievements are "neutral": the time required to acclimatize them equalled the time they subsequently spent doing useful work in the laboratory. Professor Colton believes most students in his department might benefit from taking the

Three charts show some of the results of research conducted by Doug Ross '73. The rats whose lives are chronicled by solid lines connecting solid black dots lived lives of relative normalcy in the Laboratory of Neuroendocrine Regulation in the Department of Nutrition and Food Science. They had access to rat chow during the same twelve-hour period—9 pm to 9 am—as that in which they were in relative darkness. Other rats' lives were disrupted: while their food was also available from 9 pm to 9 am, their light-darkness schedule was six hours out of phase; they were in the dark from 3 pm to 3 am. These rats' lives are chronicled by circles connected by broken lines. The daily rhythm of the hepatic enzyme tyrosine transaminase (bottom graph) proved to depend on the cycle in feeding. But the rhythm of another enzyme, tryptophan pyrrolase (middle graph), showed an increase well before food was available to rats whose dinners were offset by six hours from their periods of darkness. Yet the concentrations in plasma of the protein whose metabolism this enzyme catalyzed, tryptophan (top graph), were correlated to eating habits. Thus, while one enzyme's rhythm was accounted for by feeding cycles, another's was more mysterious.





The pineal organ takes a protein and makes from it the hormone melatonin, which appears to contribute to the regulation of activities including ovulation and sleep. To determine what influences

the production of melatonin, Jamie Eng '73 has disrupted the lives of laboratory rats. The graph shows the effect of the injection of a drug. Her research report is in preparation.

traditional laboratory course first and then moving into undergraduate research.

### III. The Regulatory Rhythms of Life

Nutrition and Food Science is a primarily graduate department; it does not grant bachelor's degrees. But it is "an unusual and very valuable place for an undergraduate to pursue an interest in research," Charles L. Cooney, Ph.D.'70, Assistant Professor of Biochemical Engineering, believes, "particularly in biomedicine or applied biology." The Department's faculty ranges from engineers to clinicians; "it provides a chance to do what I would like to think of as relevant research. We deal with biology on a more macro scale."

Professor Cooney is the U.R.O.P. coordinator in Nutrition and Food Science, which has one of the higher enrollments in the U.R.O.P. program. Of 33 faculty, Professor Cooney believes that virtually all have at one time brought undergraduates into their labs under U.R.O.P. Collaboration is also frequently with graduate students or postdoctoral researchers. He thinks the program fosters real collaboration, not simply advising; U.R.O.P. students become "almost independent investigators with appropriate supervision, not routine technicians."

Many departments have project laboratories, but in the Department of Nutrition and Food Science U.R.O.P. has allowed the project laboratories to take on a more structured format "that satisfies the commitment to undergraduate education." Meanwhile, Professor Cooney believes that the coexistent U.R.O.P. option is particularly attractive to the motivated student: "It's up to the student to seek out a faculty member, whether it be through the departmental coordinator or the individual researcher. There's some initial motivation. It's not simply filling out a

line on a registration form."

Among the specific U.R.O.P. projects that Professor Cooney has been involved with:

- The immobilization of enzymes onto small probes, where they can be used, and reused, as detectors to measure the presence and the concentration of biologically important chemicals. Six different glass enzyme probes have been developed by Doug Faller '73 and Tony Shields '73; they can test for, among others, glucose, lactic acid, and urea.

- The conversion of methyl alcohol to protein. Microorganisms that can grow at high temperatures were isolated from sewage by Brad Snedecor '75. For about half a year, a culture of these microorganisms has been living on methanol. The community is 70 per cent protein. It is not unimaginable that this might be a method of treating industrial waste and producing usable protein. The particular microorganism had never been discussed in the literature.

Professor Cooney thinks U.R.O.P. is "a good way for a student to find out what research is all about. The student experiences the same frustrations, and the same sense of satisfaction, that postgraduates and faculty do." The success/failure ratio seems good, in the sense that most students stay with U.R.O.P. beyond one semester. A few students become excellent: "I have a couple of seniors now that I'd love to retain as graduate students but they're probably going off to medical school."

Professor Cooney passed us on to Dr. Richard Wurtman, Professor of Endocrinology and Metabolism, who is associated with the Department's Laboratory of Neuroendocrine Regulation, in which 30 to 35 people work.

"Like all such things," Professor Wurtman says, "U.R.O.P. applies well only to

some M.I.T. students." Those students "become in a sense apprentices, working with an advanced postgraduate or advanced graduate student. This is not busy work in any sense. This is bona fide science." The students "become members of the Laboratory."

Professor Wurtman and his group are seeking to understand the regulatory rhythms of life by uncovering the workings of the molecules of life: hormones, enzymes, amino acids. Here then is how research conducted by undergraduates fits into the efforts of a research laboratory:

Rats have daily rhythms in their lives; they tend to eat at night and sleep during the day. Research in the laboratory has confirmed that there is a daily rhythm in enzyme concentrations in their livers as well.

In the liver, enzymes catalyze the metabolism of some of the 22 amino acids—the building blocks of all proteins. In particular, the hepatic enzyme tryptophan pyrrolase catalyzes the metabolism of the amino acid tryptophan, and the enzyme tyrosine transaminase catalyzes the metabolism of the amino acid tyrosine.

By altering the life-style of the rat—keeping him up late, starving him—the Laboratory found that the rhythm in tyrosine transaminase is related to eating patterns. But researchers were surprised to find that it was the tryptophan that produced the rhythm in tyrosine transaminase. That is, tryptophan did not control the rhythm of its own enzyme but the rhythm of an enzyme for a different amino acid.

In fact, there appear to be many cross-dependencies between amino acids and enzymes that catalyze various metabolic reactions. The matter is of interest in itself, but the amino acids tryptophan and tyrosine are of special importance: in the brain, they are used to make neural transmitters used in synapses. The transmitter serotonin appears to be of importance in regulating sleep and ovulation. Thus the rhythms of eating appear to be deeply involved in the rhythms of hepatic metabolism, and, more exciting, the rhythms of brain metabolism. There seems to be a day-to-day relation between eating and the brain that was not previously suspected.

Doug Ross, '73, will graduate at the end of this academic year—his fourth—with bachelor's and master's degrees. He plans to go on to medical school.

Doug spent his first U.R.O.P. term learning his way around the laboratory. He has now worked there for three terms, and, under a grant, made a summer job of his work as well. He dissociates his rats' feeding cycles from their life cycles in various ways, and studies enzyme concentrations in their livers. His work has culminated in a paper, co-authored with Professor Wurtman and Dr. John D. Fernstrom Ph.D.'71, now with the Roche Institute of Molecular Biology, and the research on brain serotonin content and amino acid metabolism was reported by Drs. Wurtman and Fernstrom in *Science* for October 27, 1972.

"Research is what happens in the outside world," says Doug. "Sitting in class

and reading about techniques is totally different. In books you read a simple sentence. It may take you three months to achieve it in a lab."

The pineal is a rather mystical organ that resides in the brain of all vertebrates. In earlier animal life—notably frogs—it was a light-sensitive organ, a "third eye." In higher forms, in the interior of the brain, it takes tryptophan, and with the help of several enzymes makes of it the hormone melatonin.

There is a daily rhythm to the production of melatonin; the pineal makes more during periods of darkness. Says Professor Wurtman: "The question is, How does the pineal know if the sun is shining?"

Light hitting the two remaining eyes in vertebrates creates nervous pulses, but not all are used to create the sense of vision. Some of the input is "siphoned off" through a nerve in the brain, out through the spinal cord and down to the neck. There the impulse exists via a sympathetic nerve and, curiously, returns to the head, where, in the pineal, this nerve appears to regulate enzyme activity.

In rats, melatonin regulates ovulation and appears in general to have something to do with the sensing of time. Melatonin appears to be "some kind of biological clock." In the realm of practical possibilities, research on melatonin could lead to important drugs to induce or block sleep, perhaps to affect ovulation.

Jamie Eng, '73, is a senior. She is seeking to learn what factors in a laboratory animal's life influence the production of melatonin. It is known that light and darkness do provide such an influence. Can certain drugs? Can stress? Like Ross's work, hers begins with the disruption of her rats' lives in various ways. It continues with the development of assay techniques for measuring the concentration of melatonin.

She began by using tadpoles, whose skin color reacts to the presence of melatonin. Shown to her by Dr. Harry Lynch, Research Associate in the Department, this technique promised to reveal the presence of quantities as small as  $10^{-13}$  gram. Jamie became unsatisfied with the quantitative accuracy of the assay and now uses another one—alas one that involves much chemistry and lacks something of the naive cleverness of the tadpole's skin.

U.R.O.P. research produced a focus for Jamie's classroom studies: "Because of this work," she says, "I took a certain number of related courses. It gave me one goal to which the courses applied."

Laboratory research is very different from the classroom experience: "They always give you hypothetical cases in courses." In experimental work, the problem is different—it's "trying to figure out what went wrong with your experiment, what went right." Research results are clues, one step behind truth; the question is always: "If this is the case, then what is the mechanism involved?"

Though she is a biology major, Jamie came to the Department of Nutrition and Food Science to conduct research. She was "more interested in working with animals; it's more direct than working with bacteria. Somehow, it seems more closely related to the real world."

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## Campus Patrol: "Render Unto Him Your Keepers of Order . . ."

Strolling a sylvan campus, greeting friends and passers-by, offering sanctuary to traffic-weary commuters, starting an occasional stalled car—if this was, in fact, the life of a member of the Campus Patrol . . .

But, of course, it is not.

Indeed, a report of a year's problems from James Olivieri, Captain of the M.I.T. Campus Patrol, includes a wide variety of matters which demanded skills ranging from expertise in first aid, crime, and psychology to an ability to look the other way when potentially troublesome mischief is thus best handled.

The biggest single category of problems has to do with crime. Last year \$27,000 of Institute property was reported stolen; this year the figure will be only about 10 per cent lower. Mostly it is typewriters and calculators, and the Campus Patrol now encourages everyone at M.I.T. to bolt down such machines so that making off with them is a bit less simple. Break-ins to stock rooms are another source of losses, and there's now a long waiting list of places where alarm systems are to be installed.

Close to 100 automobiles are stolen from the M.I.T. campus every year. Most are recovered within one or two weeks; in 1971, only four disappeared without trace.

Occasional cases of assault near the edges of the campus have led the Patrol to offer an escort service: if you call ahead, a car will be dispatched to the area through which you'll pass in time to meet you there.

A more difficult problem is the increasing number of "outsiders" who turn up on the campus, seeking friendship or just shelter. There have always been some, for Cambridge is a kind of mecca, but now it's getting harder because the wanderers are likely to be younger—even 12- to 16-year-olds.

One nonproblem: "an excellent working relationship" with the Cambridge Police, says Captain Olivieri. "You couldn't ask for a better understanding."

### "No Action Is Being Planned"

Perhaps the hardest decisions have to do with students: When to act, how to help, what to do.

Handle everything strictly on a law-enforcement basis? Surely not. "If you did, you'd lose the friendliness with students, lose your chance for flexibility in handling minor offenses."

Is there a code of conduct? "In 16 years at M.I.T. I don't know what it is. But there's a set of principles which is largely unwritten. . . . We lean very, very heavily on student government," says Captain Olivieri, "trying to get students to consider how they want their houses to operate, what risks they want students exposed to."

Does it work? Read this from a fall issue of *The Tech*:

"About 15 male M.I.T. students and several non-student women were found 'skinny-dipping' in the Alumni Pool last Saturday morning at 2 a.m. by Campus Patrolmen acting on a call from a night

watchman. . . . It seems that a large group of pool users got drunk Friday night and made plans to go swimming in the early morning hours. The mixed nature of the group was described by persons attending as 'incidental and almost accidental.' . . . Resisting invitations to 'come on in and join us,' the officers instead asked the participants to get out of the pool and leave. No action is being planned."

And then there is the case of a poem and parcel locker key received in the fall by Richard A. Sorenson, Associate Dean for Student Affairs:

*If you wish a Walker bust,  
This is what to do you must.  
For indeed sorry is Walker's plight.  
Who left his pedestal in thin-aired flight.  
Go to a place where visitors fly  
And where family fares are not so high.  
A vaulted wall soon must you find  
For Walker'll be lost in one day's time.  
A new life he leads, one of shine and*

*gleam  
Ready to face the harsh and extreme.  
Across the world he was known as a  
Brother  
For we would claim Him and no other.  
If our friend eludes, be you not nervous  
He's in good hands: namely, Ambassador  
Service.*

*Therefore,  
Render unto him your Keepers of Order,  
For they will serve well as his stately  
porter,  
To return him home from his locker  
And assure a Memorial to Mr. Walker.*

The Campus Patrol needed to read the poem only once before starting—with the key—for Logan Airport. There was the bust of Francis Amasa Walker which had earlier disappeared from its accustomed pedestal in Walker Memorial.

### **"If It Wasn't for Avery I Never Would Have Finished . . ."**

More than one graduate student said that about the late Avery A. Ashdown (Ph.D. '24), who died two years ago after a 50-year career at M.I.T. as a teacher of organic chemistry and Master of the Graduate House (now Ashdown House).

In addition to his M.I.T. duties, Dr. Ashdown was for over 40 years a principal figure in the Northeastern Section of the American Chemical Society; he was Editor of its monthly journal, *The Nucleus*; he served as Secretary and a member of the Board of Directors; and he was always a "wise counsellor" and a figure behind the scenes to make sure that Northeastern Section affairs went smoothly.

Since his death, Dr. Ashdown's many friends in New England have contributed to a memorial fund, and a \$1,000 check has now come to the Department of Chemistry at M.I.T. It will be used, says Glenn A. Berchtold, Head of the Department, to continue the special help for students in need which Dr. Ashdown never failed to provide throughout his lifetime.



On behalf of the Northeastern Section of the American Chemical Society of which he is Chairman, Ernest I. Becker, Head of the Chemistry Department of the University of Massachusetts, Boston, this fall gave M.I.T. a \$1,000 check to establish a memorial fund for Avery A. Ashdown (Ph.D.'24). "The way he did things was very elegant," Dr. Becker recalled of Dr. Ashdown's service to the Northeastern Section; "no one had to tell him to do anything." Glenn D. Berchtold (left), Head of the Chemistry Department, received the check for M.I.T. at a small gathering of Dr. Ashdown's closest friends—all of whom agreed that his interest in students was the greatest of Dr. Ashdown's many contributions to chemistry and to the Institute; the \$1,000 fund from the Northeastern Section will therefore become a revolving loan fund for "students in special need."

### **On Transportation Systems**

Does transportation need new engineering or new management?

At M.I.T. it is receiving both at once with the appointment of Paul O. Roberts, S.M.'57, to be Professor of Civil Engineering and Head of that Department's Transportation Systems Division, and to be Senior Lecturer in the Sloan School of Management.

Professor Roberts comes to the Institute with a civil engineering education and a background of six years' teaching in the Harvard Business School, where he was Associate Professor. His degrees are from Texas A & M University (B.S. 1955), M.I.T., and Northwestern University (Ph.D. 1966). He has consulted on transportation problems with a number of national and international groups—including last summer the government of Taiwan.

In M.I.T.'s Transportation Systems Division Professor Roberts will be associated with 20 faculty and staff members and some 40 graduate students in studies of new transportation technologies and their integration into social systems.

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## Museum Party—Scene 2

Some 325 alumni and their guests made a festive success out of the M.I.T. Alumni Center of New York's "The M.I.T. Museum Party: Scene 2." The scene last year was the Metropolitan Museum of Art, an appropriate setting for President Jerome B. Wiesner's announcement of the Council for the Arts at M.I.T. This year (the time is November 9; it is 6:30 p.m.) the scene was the Whitney Museum of American Art, and President Wiesner, unable to make it because of illness, sent a telegram of greeting and regret.

Donald R. Miller, '50, general chairman of the New York Alumni Center, presided over the Whitney's fourth floor, with a press of alumni around two bars and four tables of substantial hors d'oeuvres, cavernous spaces, a public address system not in accord with the best technology, and a stunning retrospective of the visions of Frederick Law Olmstead, noted pioneer city planner and guiding genius of New York's Central Park.

There were only a few speeches to confine the informality: John I. H. Bauer, Director of the Whitney, welcomed his guests by noting that science and art have much in common; Paul Tishman, '24, Chairman of the Council for the Arts at M.I.T., told those assembled some of the Council's plans, including a Council-sponsored five-city tour by M.I.T.'s Symphony Orchestra next spring; and Roy Lamson, Class of 1922 Professor of Literature who is also adviser to President Wiesner for the arts, called an M.I.T. education "the best education anywhere in the country" and gave convincing testimony that it would be better still when the arts begin adding more of their benign ferment to the yeast of science.

Stage manager for the event, so to speak, was Terrence K. McMahon, '57, Chairman of the Whitney Party Committee. He has a special recollection: "It's the first affair of that kind that we've broken even on, and we're very pleased about that." He assigned credit to a number of assistants: Mr. Miller, Alan W. Katzenstein, '42, Allan H. Wittman, '53, John S. Spencer, '57, Heskel Baher, '69, Eric Rosoff, S.M.'67, Lawrence S. Kaiden, '58, Po-Chiu Mar, '65, Carroll J. Brown, S.M.'46, and Mrs. Nancy A. Bord, Ph.D.'65. Thanks also, he said, to the indispensable Executive Secretary of the Center, Victoria Spencer, to Ida Rubin and Karen J. Mathiasen, S.M.'71, of the Arts Council, and Walter S. Poleshuck, Development Officer of the Whitney.

*New York's Whitney Museum provided a gracious—even spectacular—setting for the Alumni Center of New York and M.I.T.'s Council on the Arts on November 9. Some short speeches by such dignitaries are John I. H. Bauer of the Museum, Paul Tishman, '24, of the Council on the Arts, and Professor Roy Lamson, adviser to President Jerome B. Wiesner for the arts, distracted over 300 guests but little from the refreshments and the Whitney's works of art. (Photos: Marc PoKempner)*



## Does a Contested Alumni Election Mean Strife in the Ranks?

Not in 1973. For this is the first year when, under new by-laws of the Alumni Association, there are at least two candidates for all but one of the vacancies to be filled by the 1973 annual Alumni Election.

The National Nominating Committee has picked 21 candidates for 11 vacancies. In addition, new by-law provisions make possible additional nominees upon petition supported by the signatures of not less than 250 members of the Alumni Association.

Petitions for additional nominees are due at the office of the Secretary of the Alumni Association on or before March 15; ballots will be mailed to alumni on April 20, and the March/April issue of *Technology Review* will contain brief biographical sketches of the candidates and additional information about the 1973 election.

The nominees as listed by the National Nominating Committee are:

*For Members of the M.I.T. Corporation (three vacancies):*

☐ Harry B. Duane, '57, Executive Vice President, Norton Co.

☐ James M. Ewell, '37, Vice President—Manufacturing and Employee Relations, Procter and Gamble.

☐ Angus N. MacDonald, '46, President, Angus MacDonald and Co., Inc.

☐ Denman K. McNear, '48, Vice President, Southern Pacific Co.

☐ James E. Turner, '33, Former Vice President, Textron, Inc.

☐ Edward O. Vetter, '42, President, Geophysical Services, Inc.

*For President of the Alumni Association (one vacancy)*

☐ William S. Edgerly, '49, Financial Vice President, Cabot Corp.

*For Vice Presidents of the Alumni Association (two vacancies)*

☐ Norman B. Leventhal, '38, President, Beacon Construction Co.

☐ Joe F. Moore, '52, President, Bonner and Moore Associates, Inc.

☐ Susan E. Schur, '60, President, Schur Co., Inc.

☐ Hugh W. Schwarz, S.M.'42, Vice President—Corporate Planning and Director, Coca Cola Co.

*For Members of the Board of Directors of the Alumni Association (one vacancy each district):*

*District 3:*

☐ Carroll J. Brown, S.M.'46, Corporate Planning Officer, Exxon Corp.

☐ George Kaneb, '40, President, Universal Terminals, Ltd. (Canada)

*District 6:*

☐ H. Bruce Fabens, '44, Vice President, Lamson and Sessions Co.

☐ Paul Hotte, '42, Vice President—Corporate Development, P. R. Mallory International, Inc.

*District 7:*

☐ Phelps A. Walker, '40, D. H. Overmyer Co., Inc.

☐ Gordon Yamada, S.M.'62, Office of Management and Budget, Executive Office of the President

*District 8:*

☐ Robert L. Rorschach, '43, Vice President and Treasurer, Data Systems Corp.

☐ W. Terry Bray, '62, attorney, Graves, Dougherty, Gee, Moody, and Garwood, Austin, Tex.

*District 9:*

☐ James W. Barton, '39, Assistant Director—Operations and Planning, Boeing International.

☐ Warren W. Heimbach, '58, Vice President—Plans and Operations, Litton Industries.

## A Music School President from M.I.T.?

It happened late last fall when Robert S. Freeman, Associate Professor of Music, was picked to head the Eastman School of Music at the University of Rochester.

Welcoming him to the distinguished Rochester school, its Chancellor said Professor Freeman would bring to it "a remarkable combination of talent and intellectual attainments, a formidable amount of energy, and a dynamic and imaginative approach to music and the education of musicians." President Jerome B. Wiesner of M.I.T. agreed, calling Professor Freeman "a creative and dynamic member of our music community."

President Wiesner also noted that the appointment "adds testimony that the arts and music are flourishing at M.I.T. as never before."

Professor Freeman came to the Institute in 1968 after five years of teaching at Princeton because "M.I.T. gave me a chance to make a great deal of music." He studied at Harvard (B.A. 1957), Princeton (M.F.A. 1960, Ph.D. 1967) and the University of Vienna and will go to Rochester in July, 1973. Meanwhile, he will be soloist with the M.I.T. Symphony Orchestra during a West Coast tour next month.

## Henry B. Phillips, 1881-1972

Henry B. Phillips, a member of the Department of Mathematics from 1907 until his retirement in 1947 and its Head for 12 years, died at his home in Lincoln, Mass., on November 15. He was 91.

Known equally as humanist, philosopher, and mathematician, Professor Phillips contributed extensively to *Technology Review* on philosophical subjects related to mathematics and science, and he had been Radio Editor of the Boston Post for two years from 1922 to 1924. His books, all in the field of applied mathematics, include *Notes on Einstein's Theory of Gravitation*, *Vector Analysis*, and *Faraday's Law as a Basis of Electromagnetic Theory*. His lectures and discussions of science in relation to philosophy, religion, and other human affairs are remembered by many former students and other members of the M.I.T. community.

Professor Phillips was a native of South Carolina and studied at Erskine College (A.B. 1900) and Johns Hopkins (Ph.D. 1905). He came to the Institute after two years of teaching at the University of Cincinnati, and in addition to his M.I.T. appointment was for many years Consulting Professor of Physics at Brown University.

## Joseph MacAllister, 1887-1972

Joseph MacAllister, who had been associated with M.I.T. for nearly 40 years and was Manager of the Hobby Shop from 1938 to 1952, died on December 2 after a brief illness. He was 85.

Mr. MacAllister's most visible legacy are the signs designating room number and occupant(s) on countless doors throughout the Institute, rendered in precisely correct typographic style. But many generations of students will better remember his sympathetic instruction and help in the Hobby Shop, which Mr. MacAllister helped to found.

Mr. MacAllister came to the Institute in 1933 as a sign painter and—despite his "retirement"—continued to work until September, 1972, with a hand as firm as ever. He was a gifted woodworker, creating delicate pictures and seals in inlaid wood, many of which were given to friends and colleagues at the Institute; and flowers from his garden often decorated friends' desks throughout M.I.T.

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## Individuals Noteworthy

Awards and Honors: to **Stanley Backer**, '41, the first award of the Textile Information Users Council of Greenville, S.C. . . . to **Steven Weinberg**, M.I.T. Physics Department, the J. Robert Oppenheimer Memorial Prize from the Center for Theoretical Studies of the University of Miami . . . to **William R. Moomaw**, Ph.D. '65, a Dreyfus Foundation Grant for achievements in teaching chemistry in environmental studies . . . **Sheila E. Widnall**, '60, is the first woman to receive the Lawrence Sperry Award from the American Institute of Aeronautics and Astronautics . . . **Robert B. Woodward**, '36, to share the American Chemical Society's Arthur C. Cope Award for outstanding contributions to organic chemistry . . . to **Edward S. Taylor**, '24, the Robert H. Goddard Award of the American Institute of Aeronautics and Astronautics . . . to **Charles Stark Draper**, '26, the Lamme Medal from the Institute of Electrical and Electronics Engineers . . . **Elmar Piel**, '38, cited by *Industrial Research* magazine for one of 1972's top technical developments, a totally new method of chromatography . . . to **John F. Elliott**, Sc.D.'49, the 1972 Charles W. Briggs Award by the Electric Furnace Conference.

Professional and Corporate Changes: **Richard Oppen**, '29, to retire as Allied Sales Manager of Uniroyal . . . **Manfred Gans**, M.S.'51, to Vice President of Project Engineering for Scientific Design Co. . . . **Charles C. Park**, '50, appointed Vice President—Sales, Gleason Works . . . **James H. B. George**, S.M.'53, named Vice President of Arthur D. Little . . . **Edwin R. MacKethan**, S.M.'64, to Director of International Operations Business Planning of Philco-Ford Co. . . . **Frank Bader**, '56, joined Jelrus Technical Products as General Manager . . . **Philip Bragar**, '48, named Associate Director of Bedford Administration for the MITRE Corp. . . . **Winfield H. James**, '40 to become Chief Executive Officer of the New York *Daily News* . . . **Morton E. Goulder**, named to the Board of Overseers of Crotched Mountain Rehabilitation Center . . . **William K. Hooper**, '41, named Vice President, Sheet and Plate Division, Olin Corp. . . . **Sydney B. Karofsky**, '37, installed Director of the Greater Boston Hospital Association . . . **Marvin A. Asnes**, '49, elected Executive Vice President of Becton, Dickinson and Co. . . . **Herbert A. Gordon**, '66, named Vice President of Interactive Data Corp. . . . **Lawrence J. Delaune**, S.M.'52, named an Engineering Associate at Esso Research Labs, Baton Rouge . . . **William K. Adams**, '47, appointed Credit Manager, Bethlehem Steel Corp. . . . **Stanley S. Kolodkin**, '54, to Division Vice President and General Manager, R.C.A. Aerospace Systems . . . **Michael Platt**, '63 to Director of New Products, Kentucky Fried Chicken Corp. . . . **Esther M. Conwell**, M.I.T. Physics Department, to Rochester Corporate Research Center, Xerox Corp. . . . **Norman D. Day**, M.A.R.'58, named Director of Planning of The Kling Partnership, Architects, Engineers, and Planners . . . **Khee M. Chng**, '65, to Senior Scientist,

Technology Division, G.C.A. Corp. . . . **Joseph W. Hurley**, '54, appointed Director of Machine Technology, Corning Glass Works . . . **Kenneth E. McVicar**, S.M.'50, elected Vice President of the MITRE Corp. . . . **Andrew V. Nowak**, Ph.D. '72, joined the staff of the Los Alamos Scientific Laboratory in laser research . . . **J. D. Erickson**, '53, to Vice President of the Aluminum division, Kaiser Aluminum and Chemical Corp. . . . **Arthur Kantrowitz**, M.I.T. Mechanical Engineering Department, named Chairman and Chief Executive Officer of Avco Everett Research Laboratory, Inc.

Academic Appointments: **Vincent A. Fulmer**, S.M.'53, appointed a Trustee of Suffolk University . . . **Robin B. Kinnel**, Ph.D.'65, to become Associate Dean of Hamilton College . . . **E. Leigh Secrest**, Ph.D.'51, named to hold the Continental National Bank Chair of Management Science at Texas Christian University.

Professional Societies: **Roland P. Davis**, '06, to National Honor Member of Chi Epsilon, Civil Engineering Honor Fraternity . . . **Walter A. Rosenblith**, **Jack B. Dennis**, '53, **Murray Eden**, and **Leonard A. Gould**, '48, all M.I.T. Electrical Engineering Department, elected Fellows of the Institute of Electrical and Electronics Engineers . . . **Daniel J. Fink**, '48, **Wesley A. Kuhrt**, '39, and **John E. Steinder**, S.M.'41, elected Fellows of the American Institute of Aeronautics and Astronautics . . . **George R. Weppner**, '37, re-elected to the Board of Governors of the National Electrical Manufacturers Association . . . **Herbert B. Voelcker**, '51, elected a Fellow of the Institute of Electrical and Electronics Engineers . . . **Harold Chestnut**, '39, elected President of the Institute of Electrical and Electronics Engineers, Inc.

University Appointments: **R. Duncan Luce**, '45, Professor at Institute for Advanced Study, Princeton, N. J., to Professor of Social Sciences at University of California at Irvine . . . **Arthur E. Bergles**, '15, Professor of Mechanical Engineering, Georgia Tech, to Chairman, Department of Mechanical Engineering, Iowa State University . . . **James M. Duclos**, '67, to Assistant Professor, Worcester Polytechnic Institute . . . **Alfred Clark, Jr.**, Ph.D.'63, to Chairman, Department of Mechanical and Aerospace Sciences, University of Rochester . . . **Karl N. Reid, Jr.**, Sc.D.'64, to Head School of Mechanical and Aerospace Engineering, Oklahoma State University . . . **Fred Solomon**, '67, to Assistant Professor of Mathematics, Swarthmore College.

## Deceased

**Philip Burgess**, '99, November 22, 1972  
**Parker Dodge**, '07, December 22, 1972  
**Edmund L. Warren**, '08, November 17, 1971  
**Freeman A. Pretzinger**, '12, October 9, 1972  
**Dexter A. Tutein**, '17, December 13, 1972  
**Alfred T. Glassett**, '20, December 3, 1972  
**Arthur R. Harney**, '21, December 2, 1972  
**Theodore A. McArn**, '21, October 21, 1971  
**W. C. Bartow**, '24, June 30, 1972

**George P. Standley**, '27, May 20, 1972  
**Joseph R. Kendall**, '28, August 12, 1972\*  
**David M. Goodman**, '31, December 13, 1972  
**John A. Robertson**, '32, November 11, 1972  
**Shepard Roberts**, '38, November 27, 1972  
**Bernard J. Driscoll**, '42, May 15, 1971  
**Robert A. Wiegand**, '45, October 21, 1972\*  
**Robert W. Griffin**, '48, November 19, 1971\*  
**Melvin H. Saxe**, '48, July 23, 1972  
**Paul S. Dulaney**, '49, November 5, 1972  
**John F. Jackson, Jr.**, '59, January 25, 1972  
**Robert J. Keehe**, '59, October 5, 1972\*  
**Robert H. Hotvedt**, '65, December 4, 1972  
\*Further Information in *Class Review*

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# Class Review

## 96

This month we should have the notes printed in color to mark a red-letter day. On February 6 **Richard O. Elliot** will be the first member of the Class to reach the century mark. He was born just a short distance up the street from his present home on Elliot Street in Thomaston, Maine. We congratulate him on this occasion and hope the snows won't prevent a five-generation get-together in honor of the event.—**Clare Driscoll**, Acting Secretary, 2032 Belmont Rd. N.W., Washington, D.C. 20009

## 98

Greetings from Florida where your Acting Secretary has been since October. Our trailer is parked in Homestead, south of Miami. This is a grower's area, and we pick our own corn, tomatoes, beans and squash.

Please write to me at home and the mailman will forward your letter—Mrs. **Audrey Jones Jones**, Acting Secretary, 232 Fountain St., Springfield, Mass. 01108

## 99

A letter from Mrs. B. F. Kauffman of Columbus, Oh., tells of the death of **Philip Burgess**, her father, in that city on November 22. To quote from her letter, "He was absolutely amazing with his mind clear to the end. He was still able to read and follow the business world. He took special interest in his Class and all the activities of his alma mater.—**Norman E. Seavey**, Acting Secretary, Apt. 514, Lucerne Towers, Orlando, Fla. 32901

## 03

**Clarence M. Joyce** writes: "When I read your class notices, I feel a sense of gratitude that you continue to serve as Secretary. I hope your health will allow you to go on a long time.

"The last three years I have spent the summers in Idyllwild, a mountain resort for those who don't like the heat in Palm Springs and other desert communities. However, Idyllwild is not my permanent address, for my wife and I live at 31 The

Crescent, Montclair, N.J., the rest of the year."

We report the passing of three classmates:

**Paul Revere Parker** has passed away in Maine. He spent most of his busy career in San Francisco. He died April, 1972, and we await news from our office.

**Clarence M. Hardenbergh**, of Kansas City, Mo., has passed away September 9, 1972, and we await the clipping notice from the Alumni Office.

Mrs. **Adolph E. Place** announces our loyal classmate, Adolph, passed away at 95 years of age, at the end of a rugged mining engineer career in Boulder City, Nev. He died November 6, 1972, and at home as always desired.—**John J. A. Nolan**, 13 Linden Ave., Somerville, Mass.

## 04

The news is not good this month. I received a note from the Alumni Office that two of our classmates passed away recently. They are **George M. Bates** on November 12, 1972; and **Harry Needham** on September 30, 1972. No details are available.—**Eugene H. Russell**, Secretary, 82 Stevens Rd., Needham, Mass. 02192

## 05

Still a dearth of news. A few Christmas cards at date of writing, but it is apparently a national custom to use the printed Christmas message on the card and write "still living" with a signature. **Herb Bailey's** daughter Lucy sent the family letter, which is interesting to me because I have followed the family through such a medium for several years. It tells only that "my father at 92 is not quite up to writing his own this year." Thank you, Lucy. I do occasionally have a note from Herb, which indicates that he gets around pretty well. I did have a notice from a granddaughter of **Len Cronkhite** stating that they were planning a grand post card recognition of his 90th birthday on December 9, 1972. Having had a wonderful shower and tributes of many kinds on my similar occasion (July 8, 1972) I was glad to cooperate both for Ruth and myself and for the Class.

**Hal Robbins**, Course I, says he has survived another year in good shape, as does **Sam Seaver**, XIII. . . . I have a long

letter from **Gilbert Tower** apologizing for not giving me the details of his progeny, but it is so undecipherable I must write my copy and send it to him for correction before printing, but it will appear next month. It is so difficult to keep track of sons, grandchildren and great grandchildren that I get confused. Please do not let this deter you from writing all the news you wish about your family. I'll make out.

I have to record another mistake I have been making lately. On my message on birthday and Christmas cards I have made a notation "we are now 39," meaning that out of the 244 who graduated in 1905, only 39 are now living. What a mental quirk! We are now 29, and to all 29 I wish a healthy and comfortable 1973.—**Fred W. Goldthwait**, Secretary, Box 231, Center Sandwich, N.H. 03227; **William G. Ball**, Assistant Secretary, 6311 Fordham Place, Bayshore Gardens, Bradenton, Fla. 33505

## 06

On his Christmas card to us **Jack Norton** said that he and Margaret stay close to home and keep well. But as he said—you and I, Ned are now old men. He could have added—and have our limitations. Margaret takes good care of him and of their home and I can say the same thing about my Marion. Jack says they hope someday to move where they can have care and less household duties. That is what **Stew Coey** and Betty did several years ago—entered a retirement home in Vermont. On their card, Betty wrote that they can still walk and talk and sleep and eat. She felt that they are fortunate to be in such a lovely residence, with good care. Marion and I can walk and talk and sleep and eat too, but we don't get far afield now. I haven't driven the car for several years and Marion had to stop in October because of poor vision. . . . There is one death to report. **William George Abbott Jr.**, Course VI, died November 22 in Wilton, N.H., in his 91st year. Bill was with us through junior year and soon became an employee of Hillsboro Mills in Wilton and later its treasurer. Around 1935 he became President of Abbott Machine Co. By 1955 he was treasurer and a research consultant. Bill was a loyal classmate and thru the years attended our Class Reunions and

Alumni Days. A long, constructive, and rewarding life. A note of sympathy has been sent to Andrea who sent me a note reporting Bill's death. How are you doing these days? Tell it to—**E. B. Rowe**, Secretary-Treasurer, 11 Cushing Rd., Wellesley Hills, Mass. 02181

## 08

We have received from the Alumni Association a citation for classmate **Leo Loeb**, who is the recipient of the 1972 Bronze Beaver, awarded in grateful recognition of his service as advisor and counselor to the Alumni leadership, a strong advocate of the objectives of the Alumni Center of New York, and a benefactor of the Institute.

We have received a very interesting report from **Harold S. Osborn**, describing his work with the International Electro-technical Commission (I.E.C.). This is the international body which recommends to the nations of the world, standards in all fields of electrical science and industry. International standards were adopted very early in the development of electricity by a congress that met at five-year intervals. In 1904 at the congress in St. Louis, it was decided that a continuing organization was needed to carry out the growing volume of standardizing work. Thus the I.E.C. was born. The scope of its activities included the names and definitions of electric and magnetic units, electric terminology and graphic symbols, rating of equipment, and standards of performance and safety.

"As a member of the U.S. National Committee of I.E.C. for years, I had occasion from time-to-time to attend I.E.C. international conferences. In 1949, I was elected President of the U.S. National Committee. In 1952, coincident with my retirement from the American Telephone and Telegraph Co., I was elected President of the I.E.C. The term of president is three years, followed by three years on the Council as the Immediate Past President.

"At the time of my election as President of the I.E.C., at The Hague we received an invitation from Yugoslavia to hold the 1953 Convention in that country. Yugoslavia had just broken with Russia. However, at that time there was much feeling in the U.S. against anything that was labeled "Communist" so I considered it necessary to find out whether the State Department would object.

"The 1953 Convention was held in Opatija on the Dalmatian Coast. The many large hotels there had been plundered during World War II and it was necessary to house and feed several hundred delegates from 25 countries.

"After this Convention, I as President of the American National Committee, and Professor Damjanovic, President of the Yugoslav National Committee, were invited to call on Marshal Tito at his summer home on the island of Brioni. Our meeting was very informal. There were no guards or interpreters, as there was no one language that we all could speak. Tito spoke English with me and Yugoslav with Professor Damjanovic and the Professor and I spoke French.

"A few years later in 1957, the I.E.C. Convention was held in Moscow. I believe this was one of the first conventions that included delegates from the Western countries held in Russia since the revolution.

"In 1960, the Council voted that all past Presidents of the I.E.C. are life members of the two governing bodies. In this capacity, I have been a guest at I.E.C. conventions held in New Delhi, in Tokyo, and recently in Washington. During the New Delhi meeting, a small group of us were invited to meet with Nehru in his home.

"In addition to contributing something to this work, Mrs. Osborne and I have had much personal pleasure in the annual visits to countries in Europe and to the Orient. We made enduring friendships in a number of countries."—**Joseph W. Wattles**, Secretary, 500 S. Park Blvd. AG4, Venice, Fla. 33595

## 09

We were more than pleased to receive a note from **Bob Glancy** who now lives in Broomall, Pa. He was in Course VI and one of the few who easily mastered the intricacies of electric circuits and networks. He was also a member of the tug-of-war team and played on the class baseball team. After graduation he was one of those selected to be an assistant in the electrical engineering department, and later joined the Pennsylvania Telephone Co., in which he rose to the position of Executive Vice President of Operations. He writes: "Art Shaw's October letter cast light on your record as Class Secretary and that reminds me that you took time during your vacation to send a very gracious letter to me. I am physically and mentally as good as most men of my age and keenly aware that much of the world's knowledge has been acquired since 1909. As events turned out, my meager knowledge of electrical matters petered out rather than expanded since my leaning was more to materials and utilization of devices planned by others. Of scientific knowledge my ignorance is profound but somebody up the line found a place where I could do as well as other fellows could. One thing I have learned the hard way is that walking should be continued regularly if you want to enjoy living. As with athletes, legs deteriorate first. The muscles that let me squat to dig weeds out of the garden are fine but they are not the ones which propel me from place to place. I still have a driver's license which made it legal to drive 650 miles in 1971 and possibly 300 in 1972. Liability insurance on oldsters' modest basis cost 19 cents per mile. My neighborhood pal of boyhood days is in Pittsburgh and three years older than I, '08, Course VI. A telephone associate of mine in Pittsburgh celebrated his 90th birthday on March 11, 1972. I have a sister almost five years older than I am. My correspondents seem to be in that range. I suppose most elderly people find this to be so. The third great grandchild arrived this year. With your long record as Secretary it seems obvious that you are at least rea-

sonably well. Best wishes for enjoyable living."—**Chester L. Dawes**, Secretary, Pierce Hall, Harvard University, Cambridge, Mass. 02138

## 10

We have some replies to my inquiry as to how members of the Class of 1910 are doing. **Lewis S. Southwick** informs us that he returned home to the little oasis of Shelter Island from ten days in Greenport Hospital due to a heart attack. "No suffering on my part, but certainly no bed of roses for your better half who has to stay home, fend for herself, answer telephone inquiries and worry! Am now mobile again, most restrictions gradually being removed and my limit of not more than three kisses a day is entirely cleared. Claire and I are becoming reconciled to the limitations imposed by joining the senior citizens group. This growing-up process, I find, is not what it's cracked up to be, but then it never was!"

**Murray Mellish** writes, "My wife and I are still keeping busy maintaining our home—aged about equal to our combined ages. Our interests include engineering and garden activities, church and numerous hobbies. We fly to California each spring to visit a month or so with our daughter and granddaughter in Palm Springs and our granddaughter and family (two great grandchildren) in Cuperlino, a San Fran Suburb. See Ralph Horne occasionally—he's a neighbor. . . . We have a wry letter from **Ralph Horne** himself, "Thanks for your letter sent to all surviving M.I.T. '10 classmates. Your reference to how and where we are spending our 'final days of retirement' makes me wonder if you are collecting data for use in anticipated obituaries! I am still walking without a limp or cane; eyesight still good enough to drive frequently to the various New England states on business and pleasure; hearing good enough to overhear criticisms spoken behind my back, ten paces distant.

"I still go to business on an average of four times a week at the office of Fay, Spofford and Thorndike, Inc., where I continue as a Director and Consultant, having been with our company for 57 years. I attend weekly Directors' meetings at the First National Bank of Malden, Mass., where I am privileged to be a Director and Vice President. I attend monthly Trustees' meetings of the Malden Public Library, where I serve as President of the Board. There are also monthly meetings of Davenport Memorial Foundation and Davenport Home for the Aging at Malden, where I serve as President of the Board of Trustees, and Chairman of the Finance Committee. My leisure time allows me and my wife Meta to take an occasional trip to Vermont, Cape Cod, Maine, and even to the east and west coasts of Florida. I don't yet find enough leisure time to card a good golf score or even to keep my flower garden or lawn up to satisfactory display status. I manage to get a good six-hours sleep every night and thereby to 're-charge my battery' for the next day."

**G. E. Goodspeed**, Adjunct Curator of

Petrology and Professor Emeritus of Geology, writes of his recent activities, "During the summer of 1972 I continued my field studies in the Salmon River Mountains of East Central Idaho. The rocks range from a coarse-grained igneous type along lower Deep Creek upward through intermediate hybrids, to those nearly 1000 feet above. With the aid of an aneroid and a stout sack my assistant collected many specimens. Thin sections have been made from these and I am now studying them under the petrograph microscope."

**French Sargeant** replies, "Sixty one out of some 275—whew! After I retired from the Worthington Corp., some 15 years ago, Mrs. Sargeant and I moved to Florida. We do get north during the summer. A while back, **Al Hague** tried to contact me when in Clearwater. I was sorry to miss him. I never seem to get to the Florida east coast where he lives. We have family in Winter Park, Fla., a daughter married to Captain C. W. Swanson, U.S.N. Retired. Also a son in St. Louis working on a Ph.D. It might be well to put my new address here: 300 No. Osceola Ave., Clearwater, Fla., 33515.

**Hiram E. Beebe** writes, "Your letter came as I was starting in Ray Stringfield's auto for the home of Minnie Kahn—widow of Kenneth Kahn who was editor of the first good directory of the M.I.T. alumni in this area. I was the business manager of this directory—collected for the ads and turned in about \$500 to the L.A. Club in net profit. Kahn's format and style of his directory has been copied in the subsequent years after his death in 1948. I have always been a friend of Chick Kane who sketched the first-page design, heading the names of the directory committee and this has been used in all the directories since then.

"I have been in charge of the oldest group of M.I.T. alumni, since graduation as shown in the various directories. I have been prominent in my college fraternity in South Dakota—Phi Delta Theta, as Phi of the Year, and in 1966 received an engraved plaque 'Dean of Phi Delta Theta.'" . . . **Albert Huckins** replied to your Secretary, "I was delighted with your letter. In the several years since I last saw you at your Tremont St. office—before you moved—I have not gone to Boston, nor do I expect to ever go there again. I continue to live alone and now have an excellent helper who gets my lunch, and keeps track of my medication. Parkinson's disease is my complaint. Recently I spent four weeks in the hospital for tests to see how much I can take of a new drug. Dosage continues to increase a bit at a time but the end of that is in sight. My physician is very much pleased with my improvement. Nevertheless, I have given up my car and walk or take a taxi instead.

"My family remains intact. My daughter in Great Barrington, Mass., has a daughter and son married and the two other girls are in college in Colorado. My son in Topsfield, Mass., Assistant Vice President of N.E.T. and T., has a son who is a senior at Norwich University in Vermont. His other son is at home working for a building contractor at present. The two girls are in high school. Then there are

two grandchildren in high school in Illinois."—**Herbert S. Cleverdon**, Secretary, 35 Windmere Rd., Wellesley Hills, Mass.

## 11

In a nice long letter received in December, **Paul Cushman** says that he is 85 to 95 per cent recovered from the broken hip that he suffered last May. It put him in the hospital for several months, but now he walks several miles nearly every day. Paul has been deeply involved with the Masonic order. He has a Knight York Cross of Honor, having been head of a Blue Lodge, Chapter, Council, and Commandery, as well as several other positions.

**Marshall E. Comstock** passed away on November 13 at his home in West Medford. He attended Dartmouth College two years before joining our Class in the Electrical Engineering Department. He retired 20 years ago from the Boston office of the Wagner Electric Co., where he had been manager for 15 years. He and Helen celebrated their golden wedding anniversary in 1966, and have spent many summers at their place near Rockland, Maine. The Comstocks attended all but the last two of our five-year reunions and Marshall was at most of our "eleventh day of the eleventh month" dinners. He was a member of the Exchange Club of Boston and was a deacon of the West Medford Congregational Church. Besides his wife, Helen, he leaves three children, nine grand, and three great grandchildren.

**Francis M. O'Neill** died last October 13. He was a native of Holyoke and lived there all his life. He graduated from Wiliston Academy in East Hampton and attended M.I.T. in the Civil Engineering Department. He retired from the John O'Neill Construction Co., in 1952, and was for a time a member of the Holyoke Board of Public Works.

**Frank Smith** tells me he is learning to make coconut palm leaf hats from a Samoan lady and has promised to send me a sample. . . . In mid-November, **Harry Tisdale** underwent an operation in the Lee Memorial Hospital in Ft. Myers. He was in the hospital for two weeks but is now home and doing fine.—**Oberlin S. Clark**, Secretary, 50 Leonard Rd., North Weymouth, Mass. 02191

## 12

I have greatly appreciated the many letters of sympathy received from classmates who had learned of the sudden passing of my life's partner last October. I have tried to reply to all who wrote, but if I have missed any, please accept my sincere "thank you."

News continues to reduce in volume and this month it has reached the lowest in five years despite a special follow-up letter. I know that many of you do not lead exciting lives, but even a note giving the state of your general health is interesting to other classmates. . . . **Paul Tyler** writes from Florida that he had an eye operation last June on his "good" eye which has resulted in but 60 per cent of his former angle of vision and some

difficulty in walking. With an unusually hot summer, he and Katherine took a vacation trip to the mountains of northern Georgia. They were planning a trip to Disney World shortly and Paul has promised a description of his impressions. . . . **Walter Slade**, who lost his wife last spring, has since not been well, and says he has to undergo three separate operations from which he is slowly recovering. Our very best wishes, Walter, that you are by now much better.

**Dolph Martin**, our well-known musician, missed the Reunion due to a sudden business trip to London. When he last wrote, he was preparing for the production of a play in England. In his spare time, he is writing a book of poems and also his autobiography. Needless to say, his health is excellent. . . . The **Howard Cathers** are also in good health, and plan to take their usual winter trip to Florida with friends, staying at Siesta Key, near Sarasota on the west coast. . . . **Bates Torrey**, our loyal alumnus, writes that he is far from well, since he suffered a heart attack two years ago. He continues to live alone in his home, which he has been doing since his wife, Alice, was first hospitalized. Our very best wishes, Bates. . . . I received a brief note from **Jim Cook**, calling my attention to two articles on covered bridges in a magazine he had just read. All is well with Jim. . . . **Mac MacCormack** wrote from his new home in Salisbury, Md., where he moved last June (see address in October Review). He says he has been "happily indolent" there and even planted a few vegetables last summer. . . . **Harold Manning** writes to say that he and Helen are well. They have taken no trips since last summer in Maine. . . . **Vincent MacDonough**, Course X, has broken his long silence and sent me a note saying he is well and retired for 13 years. He lost his wife in 1947 so has been a widower for 25 years. I am sending his best wishes to all classmates. And that is "all they is" for this issue.—**Ray E. Wilson**, Secretary, 304 Park Ave., Swarthmore, Pa. 19081

## 13

Well, time is taking us nearer to our 60th Reunion in June 1973. We have received a good response from our letter, both for the payment of 1972-1973 dues, as well

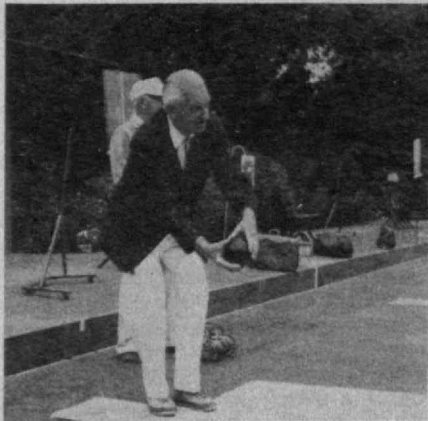
Class of '12

### MINI-REUNION SUNDAY, JUNE 3RD

Directly preceding  
International Buffet,  
Boston Pops.

ALUMNI DAY  
JUNE 3RD & 4TH

Send in coupon at end  
of class notes **NOW!**



Stanley Parker, '13, bowling on the green.

as opinions. Some due to health, age, and distance from Cambridge can not attend. As a start, those members and guests who expect or hope to attend the Reunion are Burt Cushing, the Brewsters, the Fred Lanes, the Capens, the Dave Sterns, the Allen Brewers, Charlotte Sage, the Glanceys, the Haynes, Edward Bridge, John Hession, the Harold Crawfords, Allison Butts, Stuart Eynon and daughter, and Phil Terrey. We hope that the Bill Mattsons will join us. Very interesting letters have been received from Charlotte Sage and Marguerite Rollason. By the way, Marguerite forwarded a check for Geoffrey's dues. Bill Mattson wrote a very encouraging letter and several suggestions for a successful 60th Reunion. Again **Stanley Parker** writes, and we quote: "It has been 50 years, I'm sorry to say, since I attended a class reunion. Many times I have planned to go, but something always prevented it, and time slipped by and here it is—60 years. I know I've missed a lot, but it couldn't be helped. I have enjoyed the Class Notes. Louise and I are quite well and still enjoy living here in Palo Alto. We don't travel as much as we used to, though. Incidentally she is the same girl I used to bring to Tech parties—62 years ago—how about that? I'm sorry I can't make it next June, but want to send my best regards to all my old classmates. I am enclosing a 1968 snapshot. The hair is white, but the weight is about the same."

It is always a pleasure to hear from **Allen Brewer** and we quote, "We both congratulate you and Roz for the very excellent program you have tentatively arranged for the 60th Reunion. At first I had been lukewarm about a reunion on campus, but considering the problems of transportation and limitations of movement which might beset some of us, the campus solves a lot of the potential problems. So we will plan to be there, as I have said before, D. V. In a way, too, the chance to see the changes in Boston since we climbed the stairs in Walker and Engineering A, so many years ago will be refreshing, not to mention the "chapel" in the Brunswick. By now we presume you both have gotten the new home "battened down" for the winter, with the supply of wood in the back yard.

The experts predict a water shortage for Florida one of these days, because so many northerners are moving south and buying \$30,000 condominiums or building new homes. Seems the ecology is not geared for such expansion. Did I tell you that the past several months we have been busy revising my book *Basic Lubrication Practice* which I wrote in 1955? About a year ago a publisher decided a revision would be marketable so we have been working on this and the expansion to include my two series of managerial articles which I have written for *Industrial Lubrication*, (Great Britain) the past three years. Proofs are expected any day now, with publication targeted for early 1973. We hope to have a copy of the new book with us when we come to Cambridge in June, 1973. This about sums up our Florida news. Remember the 'latch string' is still out if you folks decide on a southern trip again."

We shall miss **Gordon Howie**, but it is refreshing to hear from him and he writes: "While I can get around down here in Florida pretty well, I don't feel I would be able to keep up with the speed of all the Class at the Reunion. Our hot summer has only ended in the last few days with cooler weather taking over. I can, in my imagination, feel your nice Biddeford temperature, as I formerly lived on Drake Island in Wells, Maine." . . . **Jack Farwell** always brightens our day and he states: "You did a nice job planning the program for the Reunion. I note in the December *Review* that you had consulting service from Bill Brewster. We expect to attend the Reunion. It is now "we." Last June, Jane Greene, a neighbor and friend of many years, and I were married. Jane is looking forward to the Reunion and meeting such a distinguished group. As to 'activities'—have been enjoying life here in Connecticut with short trips such as to Florida last June. Still trying to keep up with nature through the seasons. Snow plowing, then mowing and gardening; in June fighting span worms and gypsy moths; then leaves in November with power vac equipment, and so it goes. Here's hoping for a good turn-out for the Reunion." Congratulations, Jack. We shall be looking forward to meeting Jane.

We regret to report the death of our classmate, **J. Murray Hastings** on November 6, 1972: "J. Murray Hastings, 82, formerly associated with the Mutual Benefit Life Insurance Co., until his retirement in 1964, died yesterday at his home. He was born in Mount Morris and had resided in Syracuse 44 years. Mr. Hastings was a graduate of Storm King School, Cornwall-on-Hudson, and Hamilton College, class of 1910. He received a master of science degree from M.I.T. in 1913, after which he worked for Solvay Process Co., in Detroit, Mich. He moved to Syracuse in 1919 and was placed in charge of the coke oven plant of Solvay Process. Mr. Hastings served as a first lieutenant in the Army during World War I. He formerly was President of the Syracuse Association of the Blind and a member of the Liederkranz Club, Century Club, University Club and the Newcomen Society. He was a life member of the Million Dollar Round Table and

a communicant of St. Paul's Cathedral. Surviving are his wife, Marian Shove Hastings; a son, a sister, and two grandchildren. Services were held in St. Paul's Cathedral. We are extending our sympathy to Mrs. Hastings and Murray's family.

Several letters of November 15, 1972 were returned (Leland S. Becker, North Largo, Fla., marked deceased; Leon M. Hecht, Nashville, Tenn., and Winfred S. Boynton, Mason, Ohio, marked address unknown.) Can any of you classmates give us information of these classmates?

Keep the ball rolling and join us at the 60th Reunion.—**George Philip Capen**, Secretary and Treasurer, **Rosalind R. Capen**, Assistant Secretary, Granite Point Rd., Biddeford, Maine 04005

## 14

**Ray Dinsmore** and Violet went to the International Chemical Engineering Congress in Japan for one month last October. Ray very kindly agreed to give us the account which follows: "Since our visit was short and very likely our classmates have experienced or read more about Japan than I would be able to write down, I decided to give you some of my impressions of the country and the people. Generally, we went from the south to the southwest and back to the northeast and east, stopping at such places as Tokyo, Nagasaki, Hiroshima, Kobe, Osaka, Nagoya and back to Tokyo. For an American with no knowledge of Japanese, travel without a guide or interpreter is tedious and difficult. Taxis are cheap, and there are good express trains. Drivers are very skillful. The attitude of the Japanese toward Americans is generally courteous. In the past ten years an affluent middle class has developed, which is an entirely new factor in Japanese society resulting in numerous cars, wide-spread use of radios and TV and greatly increased buying of better and more balanced foods. One of the surprising results of this latter move is to make good fish scarce and expensive. Perhaps of great interest to every visitor is the fact that water and raw vegetables are safe anywhere the tourist goes. The architecture seemed to me a strange mixture of very old, fairly modern and very modern. I found the very old and the very new quite attractive. They have developed interesting combinations of curved surfaces and intersecting planes for exterior and interior design. Inside they have used pleasing lighting effects.

"Through my attendance at the Congress in the new Convention Hall at the outskirts of Kyoto, I was able to talk to natives and foreign visitors.

"The Japanese are very industrious—the old and the young of both sexes work if family conditions require it. Those who go to colleges and universities, we are told, have a stiff workload and most of them are quite diligent and take advantage of their opportunities. It was evident, even to the casual observer, that from a very early age the students are put through hard physical training every day. An example of this is a seven-year old, pole vaulting. Farming seems to be a mixture

of small, hand-cultivated farms and larger farms—and some mechanization. Mountain slopes are terraced, irrigated and farmed like the Swiss Alps, except that the Japanese are blessed with more frequent summer rains. There are many small factories and a growing number of large cement, steel, textile, automobile, electronic, and optical equipment factories. The new manufacturing generation takes pride in quality, new design, and fine appearance. Long hours are customary and we were told that the use of weekly or daily pay does not reduce productivity. Incidentally, dining service there is the fastest and most cheerful and efficient that I have ever seen. A visit to a Kyoto family was very rewarding. We were lucky to have a hostess who is a college graduate and an English tutor. She was eager to ask questions about the U.S.A. Air and water pollution are quite evidently a larger problem to municipal areas than they are here. The Ch.E. Congress had many papers on these subjects. My impression was that scientists and engineers are well trained and anxious to broaden their knowledge by international exchange. In commerce, the resentment against the U.S. is rather strong because of our political moves to restrict exports to this country or to force up-valuing of the yen.

"There is a strong trade leaning toward the east but apparently no wish to take on a satellite status. They would like the U.S.A. to continue the atomic-bomb umbrella, but otherwise to hold aloof. There was little bitterness expressed or seen with respect to the bombing of the last war. As a matter of fact, the rebuilding and the aid which has been given and is still being given by the U.S., has enabled Japan to assume its position among the important nations of the world."

**Louis Charm** wrote in October, "I am now located in the Fellowship House in Reston, Va. It is a new nine-story building near an artificial lake (Anne) surrounded by a shopping area, apartments, and single houses. The Fellowship House has over 100 tenants; and we have a chapter of the A.A.R.P. organization, of which I am Vice President. The whole area is picturesque and convenient, and the climate is moderate. In my spare time I am writing memoirs, at my son's request. I have written four 'chapters' and my readers are clamoring for more." . . . **Estus Magoon** writes that he is a member of the South Florida M.I.T. Club, and that he and his wife enjoy its activities very much.

Mrs. **Harry M. Varrell**, the former Laura K. Johnson, died in York, Maine, on October 23, 1972. After her graduation from Cornell in 1910, she was with us at the Institute during our first two years. She became an instructor at Simmons College, and in 1916 married Mr. Varrell, a professor of history and Dean of the Graduate School at that college. She and her husband owned and operated the former Yorkshire Inn at York Harbor during the summer months. After his death in 1940, Mrs. Varrell continued to operate the Inn until 1954. She leaves two daughters, four grandchildren, and a great grandson.

New addresses: **Eugenio Garza Sada**, P.O. Box 755, Monterrey, Mexico Mx560; **E. Mortimer Newlin**, Box 308, Villanova, Pa. 19085.—**Charles H. Chatfield**, Secretary, 177 Steele Rd., West Hartford, Ct. 06119

## 15

Happy New Year! With the hope that you and your families have all enjoyed a pleasant holiday season. While researching in the Class archives, the old Pirate and I found some pictures taken at our 50th Reunion at Coonamessett Inn. We sent them to the classmates in the shots. It was sad to see the number who had passed on since those pictures were taken. In answer, **Gil Peakes** wrote, "That was a happy thought for you to send the old picture from 1950. I shall cherish it. It reminds me of something for you. Your column seems always to be asking for news. Here is some. I enclose a news note about a trophy I won in the philatelic field in Baltimore on September 1. There was also another award for the same exhibit. I also enclose a copy of the *United States Specialist* for November, where I am mentioned on the front cover, p. 482 and p. 487.

"On Saturday, November 18, I visited the big stamp show in New York and saw **Joe Livermore** strolling by. We had a short chat. Joe reported no big troubles and seemed to be in good health. He was formerly a stamp collector but has now sold most of his stamps and no longer collects actively. Me—I do keep on collecting but have restricted my field of activity. Healthwise, everybody at this address is doing fine. My best regards to the top Class Secretary."

Congratulations to **Gil** on his winning the **Walter W. Hopkinson Memorial Trophy** and a "**Balpex**" gold award. **Gil's** learned winning paper showed a lot of research and detailed work and read like a senior thesis.

**Rush B. Cady** died July 17 in St. Petersburg. . . . **Dr. Henry E. Berger** died October 31 in Wellesley, Mass.

How about some personal letters about yourselves for our column? Is my old cry of "Help Azel" falling on deaf ears?—**Azel W. Mack**, Secretary, 100 Memorial Dr., Apt. 26-A, Cambridge, Mass.

## 16

Grown men are like little boys but with a love for expensive toys. That surely applies to our ever-doing President, **Ralph Fletcher**, but with a difference. Not only does he still go to the office practically every day in West Chelmsford, but we hear he continues to come up with novel ideas for new costly toys, some small, some large, but all unique as labor-saving toys for use in the outer quarry itself and for processing some of the quality products of granite. "Amazing" is the word for it!

Even our own little local newspaper in New Jersey has '16 news items. Here's one we found in the November 2 issue of the *Times-Bulletin*, in its column on "The Talk of Mountain Lakes," about our busy

energetic neighbor **Elsa Mueser**: "Memories were nostalgically evoked at the delightful wine luncheon commemorating the College Club of Mountain Lakes' 50th anniversary. Past presidents of this branch of the American Association of University Women came from as far away as Texas and New Hampshire for the occasion. Elsa Mueser of Lake Drive is a charter member of the group as well as a past president, and was an honored guest." Elsa mentions that she had just spent a few weeks in Maine and hoped to go to Europe in a few months, for "everyone is doing it and there is so much left to see. One grandson, a Junior in Harvard, editor of the *Crimson*—skipped a whole year. No one for M.I.T. although the material is good. What a wonderful choice for those who are ambitious. Love to all."

In October, we had a familiar-voice call from **Dina Coleman** right near by in Livingston, N.J., where he said he was undergoing the St. Barnabas "hyperbaric experiment" in the hospital. On his return to Lexington, Ky., he reported that "the experiment did not produce any measurable results. Maybe I didn't need the treatments in the first place. All my 'do-good' enterprises are going well. We expect to pay the last \$20,000 note at a fun-and-games party this week, in the new Cerebral Palsy School, built without any help from Washington."

From **Charlie Lawrance** of Kingston comes a newspaper clipping from Bangor, Maine that we'll put on the bulletin board for all to read at the Reunion in June. The title tells the story: "Technology's Golden Age Lies Mothballed at 'The Old Tech Camp.'" It's all about the old Surveying and Engineering Camp in East Machias, Maine, where, as Charlie says, "Course I and XI engineers attended camp as Tech's busiest beavers, having field and office work for the professional life of civil and sanitary engineers." And moreover, as verified by **Dave Patten**, that's where Charlie found Lois and "made no mistake." We mechanical, electrical and chemical engineers used to wonder just exactly what those boys really did at summer camp. M.I.T. controlled 25 buildings high above Gardner's Lake and 700-plus acres. We understand any I or XI man will be very glad to talk at length about it. Charlie reiterates that the camp has a very spe-

Class of '16

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cial meaning to him and wonders "where the engineering students now get their field and office experience." . . . Go, go, go—that's Gladys and **Francis Stern**. They had a seven-week trip in the Canadian northwest in August with their daughter and son-in-law. Following a flight to Spokane, they went by car to their daughter's place in Sand Point, Idaho, then on to Banff, Lake Louise, and a week in Jasper National park. Then westward via Kamloops to Vancouver, which impressed Francis "as spectacular in contrast to our American cities that seem to be unable to get out from under their own shadow." Francis notes proudly that his oldest grandson is now a Professor of Math in Miami University. He adds: "The best philosophy is to remember you went to M.I.T. and tried to make the rest of your life worthy of it."

We've had a good letter from **Moses Wolk** of Mattapan telling a bit of his doings in these retirement years. He brings back memories of several things in our early days at Tech and some of our earliest impressions. He asks: "Do you remember the first day in Rogers Building—with every desk carved with a dozen initials?" And when he mentions our first math professor, E. B. Wilson, I recall the shock on receiving my first F in a math quiz, but then his assurance that "most everyone got a double F!" Later, his description of a cusp, with its second order degree of sharpness, was never forgotten, for he said, "A cusp is something that would hurt worse to sit on than any triangle you could conceive of." As someone has reportedly said "Them were the days!" . . . In November, we had a colorful post card from Hotel Maeva Beach in Tahiti from guess who? Not Virginia and **Joel Connolly** who have arrived home in Tucson after their far-ranging travels in the Pacific—but from Pearl (Mrs. **Bob Wilson**) who started out in mid-October for a nine-week trip out Tahiti way and to Australia. In response to one of our old post cards of Isleta Indian Pueblo near Albuquerque, she notes that she and Bob stopped there in 1925 on their way to an American Chemical Society meeting in Los Angeles.

Here's something for those of you who may be or purport to be farmers. We wrote **John Fairfield** of Troy, N.Y., about the high level of success we attained using beer in a tin plate for catching slugs in the garden. In several trials, a more expensive imported beer was the most effective. John replied with two other examples. One man mulched his rhubarb with old magazines. John didn't say whether the *National Geographic* or *Life* or *Playboy* gave the most prolific stalks. "Another chap raising radishes indoors undertook an experiment—same soil, seed, sunshine, moisture, etc., and divided into four plots: the first, a control with no music; the second, Beatle music for an hour a day; the third, opera for an hour; the fourth, an hour of some other kind of music. Results: the Beatle group, 350 per cent growth, the opera group, 120 per cent growth, the fourth group, 105 per cent; the control group 100 per cent. So what?" If you have an answer, write John. 75 Euclid Ave., Troy. He wants to know. . . . Some people have a

yen to travel, visit, and celebrate Thanksgiving. We have no complete count for '16ers but can report two pairs of travelers. Dolly and **Len Stone** of Jackson Heights, N.Y., enjoyed the holiday with their granddaughter and husband in San Antonio; and Louise and **Harold Mills** of Mtn. Lakes, N.J., flew out to San Francisco to join in thanks with a daughter and her family. . . . Back in July from Golden, Colo., came **George Hale's** reassertion, "Colorado is a delightful location," then his wish that it were not so far from Cambridge and M.I.T. . . . And **Mac McCarthy**, speaking of a recent birthday, had this to say: "Guess we are all getting to that state in life when it is an achievement of some importance to be able to register one more anniversary."

**Rudi Gruber** says his younger brother in Germany again insisted on a joint celebration of Rudi's June 3 birthdate. Rudi visited Lindau, Bodensee, West Germany at Lake Constance and "participated in the annual Nobel Laureate meeting which is attended by scientists from all over the world—many from the U.S." As a member of the M.I.T. Corporation Development Committee, he has frequent occasion to meet in Cambridge, the last event on October 6 and 7. As he adds to his birthday, he says, "I am grateful to the good Lord that he permits me to 'keep in circulation' in spite of some 'osteoarthritis' which forced me to join the 'cane-gang'—but I get around by myself, nevertheless." . . . We are often reminded of **Dick Berger's** publications on the danger of lung cancer from tobacco smoking ten years prior to the Cancer Society's espousal of publicity regarding the problem. Now Dick echoes the Heart Association's publicity regarding "the menace to health from cholesterol, mostly in solid animal fats such as butter, animal fats, and egg yolks which should be replaced by vegetable oils."

The New York 1916-1917 monthly luncheons are still percolating. In November at the Chemists' Club, those in attendance included '16ers Rudi Gruber, Mac McCarthy, and Len Stone, and '17ers Dick Loengard, Clarence Seeley and Bill Newman. For details of when and where, drop Len Stone a penny postcard (now only 6¢). Now that the New Year is well under way, it won't be long before you'll be hearing all about the 57th Reunion at Chatham Bars Inn—good old Chatham Bars Inn out on the Cape. We are grateful for the fine way you reply to our little requests for news and philosophy for the Class column—just keep up the quick replies to our animated dunning letters. —**Harold F. Dodge**, Secretary, 96 Briarcliff Rd., Mtn. Lakes, N.J. 07046; **Leonard Stone**, Assistant Secretary, 34-16 85th St., Jackson Heights, N.Y. 11372

# 17

Sturbridge versus Northfield—that is the question for October 1973. There has been just enough comment in favor of our 1973 Interim Reunion being held at the Publick House in Sturbridge, Mass., to consider having a vote as to preference. Those of you who have been to both

places may be neutral or definitely favor one. At Northfield, we are all under one roof, in attractive surroundings and atmosphere, pretty much to ourselves with good food. At Sturbridge we would have the Treadway Annex up on the hill to house most of us with others at the main inn, Publick House. Some think the food there is superior. There is the added attraction of the always interesting Old Sturbridge Village, the reproduction of a New England colonial village. Which shall it be? Your comments are desired and will be appreciated.

The last word of the globe-trotting Denens was from Germany about to take off for Spain. . . . There is an interesting letter from Conchita Lobdell Pearson telling of a fine trip she took this fall. With a group of friends from Mexico City she visited Leningrad, Moscow, Prague, Budapest, Istanbul and the Greek Islands. She expresses her pleasure and thanks for all the happenings at our 55th. . . . Betty and **Ray Ramsey** have had two good full-semester trips as students with the World Campus Afloat, operated by Chapman College of Orange, Calif. The first, in 1965, was around the world, through the Mediterranean, Suez Canal and the Orient. The course this spring—six ports around Africa and then the Orient. Ray writes, "We had many rewarding contacts with natives in the 16 countries we visited. We were the only old students, being, in fact, grandparents to the whole ship, including the 420 students. In practically every port some native seeing us with young students would call me professor. In Casablanca, a bus guide so addressed me and when I explained that I was a student he asked, 'Are you being recycled?' We enjoyed the fellowship and friendship of the students. We have lots of confidence in young people. The students were just great. Since retirement in 1960 I have done consulting work and enjoyed traveling all over Europe, to Russia on a Russian ship, Alaska, South America and the Caribbean."

**Paul Dudley** had a heart attack last July but is coming along well. . . . In the interests of accuracy and the vignette in last month's notes, any Course VI man knows that it was not "radio" in 1911. So it was "wireless" that our two budding engineers developed.

The death of **Roger L. Putnam** at Springfield, Mass., on November 24, is recorded with regret.—**Stanley C. Dunning**, Secretary, 6 Jason St., Arlington, Mass. 02174; **Richard L. Loengard**, Assistant Secretary, 21 East 87th St., New York, N.Y. 10028

# 18

Some of you who attended our Mini-reunion at Endicott House in October will recall that **Sam Chamberlain** became ill during the afternoon. Three days later he was operated on for a ruptured appendix at the Salem Hospital. The recovery is slow but he is expected home before the end of December. All our good wishes and prayers go to him for a recovery to normal good health within the next two to three months. Sizuo Truiji, his counterpart in writing books on gourmet cook-



Members of the Class of 1918 gather for a class photograph at Endicott House.

The occasion was a Mini-reunion held there last October.

ing in Japan, learned of Sam's ordeal at the hospital—came on the next flight from Osaka to Salem, Mass., spent an hour with Sam—and returned on the next plane to Japan. He regards Sam as a father and this is something he felt compelled to do. Recently, Sam was given a special award by the National Trust for Historic Preservation—all reported in detail by Walter M. Whitehill in a recent issue of *Antiques*:

"The National Trust for Historic Preservation last May honored Samuel Chamberlain with a special award for his outstanding services to historic preservation as a graphic artist and photographer. He entered M.I.T. in the days when architects aspired to be artists, rather than engineers or mechanics, and when drawing was not necessarily shackled to the T-square and compass. Architects produced handsome renderings for their clients but often indulged in drawing and etching for pleasure. This Mr. Chamberlain did after joining the American Field Service. Having lost his heart to France, he stayed there drawing and photographing architectural subjects. He is an honorary member of the American Institute of Architects and an honorary Master of Arts of Marlboro College.

"In 1936 he began publishing books of photographic studies of American buildings, towns and landscapes such as Salem and Williamsburg. Thus he has had a great influence upon the American people in making them aware of the beauty of 18th and 19th century buildings and their furnishings.

"Although Mr. Chamberlain is remarkably productive he composes every picture in his mind beforehand; setting his camera on a tripod, he will wait a whole day, if necessary, for a certain intensity of light and shade before taking a single picture. His autobiographical *Etched in Sunlight, Fifty Years in the Graphic Arts*, describes his life in etching lithography, drypoint, photography, writing, and gastronomy."

In the previous issue of the *Review* we printed the news item of the highest honor given **Craig Hazelet** by the Ameri-

can Society of Civil Engineers. I am happy to add a personal note from Craig: "I will never forget the 50th Reunion of the Class where you and several other stalwarts did yeoman service by making us acquainted with many members who we had not previously met. Of course you had assistance from Sax Fletcher, Sam Chamberlain, Julie Howe, Jack Po-teat, John Kilduff and others too numerous to mention." A clipping from the *Professional Engineer*, a magazine sponsored by the Kentucky Society of Professional Engineers, contains the highlights of Craig's professional activities. He received bridge awards for two major structures over the Ohio River. One is the twin 1000 foot double deck span now named the Sherman Minton Bridge. The other is the John F. Kennedy Bridge which spans the Ohio River between Louisville and Jeffersonville, Indiana. The awards are made for architectural excellence and are sponsored by the American Institute of Steel Construction. Stainless steel plaques inscribed with the designer's name are welded to the portal to identify the structures. "At present we have four bridges currently under construction over the Ohio River. Also one over the Mississippi River at Memphis. Mrs. Hazelet (Frances) who is the prime mover of our *Pad* has held that position since November 12, 1920. We also have two married daughters, five grandchildren and one great grandchild. My older daughter Sue is married to John H. Clark, III, who is now a partner in the firm. This gives me more time to spend on the golf course trying to make another **HOLE IN ONE**. Sally, our younger daughter is married to Wick (F.W.) Drummond. In the fall of this year, Sally was invited to have a one "man" Retrospective show at the Corcoran Gallery in Washington, D.C. Of course Frances and I donned Top Hat and Tails and were at the opening."

We were happy to receive greetings from many of you—which we acknowledge here. We list a newsy letter from **Granny Smith**:

"This is the 'Year That Was'! It began

unauspiciously enough with a visit from family and friends from Canada and New Jersey which made our winter delightful. I became much involved in Military Order of World Wars with our local chapter playing host to the whole State of Florida in a big convention. The next week Dottie had to have open heart surgery and did not return home until two weeks later. Then on June 19, another disaster struck in the form of hurricane Agnes. We decided to stick it out here due to Dot's condition, only to have the Sheriff wake us at 3 A.M., ordering everyone off Siesta Key. During this spell, I was "chief cook and bottle washer" ably assisted by neighbors.

We later made a visit to our younger son in Gales Ferry, Ct., and our older son enroute home. We returned by September and as Dot gets better we are looking forward to enjoying life again. I am now the President of the local M.I.T. Club. Will try to make the 55th Reunion."

Your Secretary has become involved for the Alumni as an advisor to a group of students who are in the M.I.T. Undergraduate Research Opportunities Program. These undergraduates, working under the direction of Professor Burnham of the Department of Political Science, are doing research on the dele-

Classes of '17, '18

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gates of the Democratic Party dating from the convention in Miami to the present. This research is important because it hopes to determine whether these delegates gave their all for McGovern after the convention or became disenchanted. In particular, they hope to find out if they will become involved in the 1976 political arena. It is the purpose of our Alumni Committee, on which I serve, to involve at least 50 of us in U.R.O.P. with beneficial results for the students and the alumni.

We were happy to receive a call from **Ned Longley** from Santa Ana, Calif., where he was spending the Christmas holidays with his children and grandchildren. . . . The Longleys and the **Walter Robertsons** are about to go to England and other parts of Europe in the spring but want to be back in time for our 55th, which starts June 1. . . . The **Wingate Rollinses** will spend a part of this winter in Europe as will the **Eli Bermans**, who are to be in Spain. Mrs. Rollins has completely recovered from a broken leg which was responsible for their not being with us at our Mini-reunion. . . . The **Tom Brosnahan**s will be in Austria in February where he expects to complete his book on their many travels all over the world. . . . **Julian Avery** is writing a paper on Astrophysics and Cosmology.

We note the following report in the *New York Times*, dated November 20: "**Joseph O. May** died on November 19, 1972. He was with the American Bridge Division of the U.S. Steel Corp., from 1910 to 1956 when he retired to private practice. He was a consulting engineer for many companies, including Sea Train Lines and the International Nickel Co. Mr. May graduated from Cooper Union and did graduate work at M.I.T. He worked on the design of the George Washington and Tappan Zee bridges. He is survived by a daughter, two sons, two sisters, and two brothers." The sincere sympathy of the Class is extended to his family. (Editor's Note: We apologize for inadvertently omitting Mr. Levine's name in the previous issue.)—**Max Seltzer**, Secretary, 60 Longwood Ave., Brookline, Mass. 02146; **Leonard Levine**, Assistant Secretary, 519 Washington St., Apt. 15, Brookline, Mass. 02146

## 19

Your Secretary reports with sadness the passing of **Lloyd R. Sorenson** in Yorktown, Va., on June 30, 1972. No further details are available at this writing. . . . Also with regret we announce the passing of "**Otto**" **Adolf Müller**, the artist of our "Twenty-Five Years After" booklet of 1944. A letter from Davis M. McFarland, '18, from West Chester, Pa., furnished the details. Otto passed away on November 21. He and his wife Eleanor had been on cruise and returned September 14. Otto quite suddenly started developing a yellow color. Tests at the hospital showed an obstruction in the bile duct that proved to be cancerous. They tried chemo-therapy but with no success and the last ten days he was in a coma. Dave writes—"Otto was my roommate in the

Beta House and a finer more gracious person I have never known. Otto was a very successful bank architect and is included in *Who's Who*. Have not run into Ren Smith for several years. Hope he is in good shape and enjoying life."

**Marshall Balfour** and Margaret stopped at Delray Beach on December 1 and your Secretary and wife had lunch with them. "Bal" is still in Chapel Hill, N.C., as Visiting Professor at the University of North Carolina. We had a very enjoyable time reminiscing and discussing our classmates and looking forward to our 55th in 1974.—**E. R. Smoley**, Secretary, 50 East Rd. Apt. 11E, Delray Beach, Fla. 33444

## 20

A few items which serve to emphasize the fact that our Class continues its dauntless career with energy and zest unhampered by the passing years.

**Sam Schenberg** writes from Miami Beach, "We have been here for 15 months and find the people down here most friendly." (Knowing you, Sam we cannot say this surprises us.) "M.I.T. has an alumni club here and the meetings afford all of us an opportunity to get together and discuss the present with its roots in the past. The secret of continuous rejuvenation seems to be in the direction of mental stimulation. Last spring I offered my services to the Dean of Education at Miami University. As a result I am working with a number of teacher-interns, visiting different schools and watching them perform their teaching services. I am looking forward to doing it again next year. We are in excellent health and hope you and all other members of the Class are in the same state." Good old Sam! . . . **Al Wason** proudly announces that he has become a great grandfather of a great grand daughter. Says Al, "Growing old is simply a question of mind over matter—if you don't mind, it doesn't matter. Retirement is wonderful!" . . . **Herman Marrow** writes that he has just returned from a trip to Israel, London, Paris and Rome.

**Don Kimball** tells of his impending golden wedding anniversary to "a yankee gal from Newton Centre, Evelyn Morton, whom I met while at M.I.T." Don, who lives at 76 No. Country Club Drive, Rochester, N.Y., boasts of two great grandsons. . . . **Buck Clark** announces his association with Tucker, Anthony and R. L. Day of Hartford, as a registered representative. "Good for another ten years," says Myron. . . . Looking mighty sharp and jaunty, according to his picture in the paper, is **Buzz Burroughs** who headed up a "bonspiel" for the International Ross Tarlton Curling Competition at Winchester Country Club. We understand that Buzz is as good a curler as he is a golfer, and that's saying quite a bit. . . . **George Wilson** of Braintree, Mass., writes that he keeps busy enjoying his hobbies, among which is a sizable collection of minerals.

**Tony Anable** was the recipient of the Golden Oak Leaf Award of Nature Conservancy for outstanding voluntary ef-

forts in the cause of conservation. Tony is one of the founders and is presently Treasurer of the Mianus River Gorge Conservation Project. The award was presented at a meeting of Nature Conservancy at Mohawk Mountain House, New Paltz, N.Y., where Tony gave an address on the subject, "Preserve Management."

The Class suffers a grievous loss in the death of **George E. Rowe** of 72 Somerset St., Wethersfield, Conn. George had been associated with Ernhart Corp., for more than 50 years. He was awarded some 70 patents for his inventions during his development engineering career. Born in England, he had lived in Wethersfield for many years. He leaves his wife, Selma, a son and three daughters, and eight grandchildren. In a letter to Norrie Abbott, Selma writes, "We were able to attend the 50th Reunion which was a delight from beginning to end." In making a gift to the Alumni Fund in his memory Selma says, "George was a loyal M.I.T. man and was very proud of his association with the Institute." . . . Word has been received of the death of **Edward M. Howard** of 201 So. Cherry St., Lexington, Ill.

We have also received late word of the death of our widely known and loved **Al Glassett** in Pompano Beach, Fla. Al had suffered a series of strokes in recent months and had been incapacitated for some time. A distinguished alumnus, former President of the Alumni Association and a guiding spirit of the Alumni Club of New York City, his passing is a blow to us all. He is survived by his wife, Esther, of 111 No. Pompano Beach Blvd. More about Al will appear in next month's Class Notes.—**Harold Bugbee**, Secretary, 21 Everell Rd., Winchester, Mass. 01890

## 21

A number of classmates have written to urge that an **Interim Reunion** in Florida be held this year rather than waiting until 1974. They note obituaries in this column almost every month and state simply that "time marches on." Consequently **Al Lloyd**, Interim Reunion Chairman, has appointed a working committee in Florida headed by **A. H. Rodriguez** of Tampa and including **Allen Addicks**, **Oliver Bardes**, and **Josh Crosby**. On the east coast of Florida, **Edward (Scripps) Booth**, **George Schnitzler**, and **Miles Zoller** are assisting. The sticky question is availability of hotel rooms but if this is resolved, a letter will have gone out to each of you before these Class Notes reach you. The dates proposed are just prior to the 25th Fiesta in Mexico so that attendance at both Reunions is possible. Direct flights are available from Tampa or Miami to Mexico City. Whether this Florida Reunion jells or not, write A. H. Rodriguez, 4015 Bayshore Blvd., Apt. 5C, Tampa, Fla. 33611 and tell him when and where you will be in Florida this winter. He can supply names of classmates within 50 miles so that informal cocktail parties and dinners can be arranged. Come join us at either or both affairs for fun with Twenty One.

A copy of **Laurence Buckner's** color

montage was recently received by your Secretary. It contains 70 color pictures of individuals or couples at our 50th Reunion. It was a welcome addition to our photographic gallery and fun to try to identify everyone. . . . **Robert Miller**, our class photographer, arranged for the printing and will prepare an identification sheet. Order the montage directly from Bob. The thanks of the Class go out to Buck for his 50 hours spent in assembling the montage and to Bob for his labors in completing the job.

Through underground channels we learned at our last Reunion that **Dana Kepner** of Denver, Colo., had written and published two short stories with the primary purpose of entertaining his grandchildren. A letter to Kep brought forth a reply and the gift of the two paperback stories, amusingly illustrated by the author's sketches. Many thanks! Kep has six grandchildren, two of whom are attending the French section of the Eurach school in Varese, Italy, and speak French, Italian, German and English fluently. Quoting Kep, "They look at me often and say, 'granddaddy, can't you understand anything but English?' I'm prompted to give you a bit of modern Mother Goose: What are little grandchildren made of? Sugar and spice and everything nice, with peaches and cream complexions. And what are old grandfathers made of? Kidney stones and aching bones, with wrinkled skin all over." Alas, how true! Kep says, "I am semi-retired and thus should be only half as busy but I find it difficult to get in a normal quota of concentrated loafing."

A welcome letter from our good correspondent, **Wallace T. Adams** of Middletown, Oh., gave a brief rundown of he and Anne's trip to the British Isles last summer: "Covered a lot of territory; hedge rows made it generally impossible to see much when driving a car so we took to riding high in the coach buses. Got saturated with cathedrals and old ruins. At Stratford-on-Avon, we invited to lunch an Anglican Rector and his wife, who were scheduled to swap jobs for the month of August with the Associate Rector of my church in Middletown. The rectory in England is 503 years old and the church building goes back to about 1100 A.D. Our congregation entertained and enjoyed the English Rector and his family." . . . Wally reports that "Ocy" and **Al Breed** of Laconia, N.H., celebrated their 50th wedding anniversary October 9, with a grand party. Congratulations! Wally's wife Anne is busy with her art work, mostly enamelling copper but also working with oils. . . . A postcard from **Al Fowler** states that he and Helen departed from their previous home in Somerville, N.J., and drove 1800 miles to Denver in four days. What a bear for punishment!

Alumni Fund envelopes continue to be a source of news from our classmates. **Al Genaske** of Fryeburg, Me., wrote that he had a hernia operation last June and then fell and broke four ribs taking a dock apart in October. "Coming along fine and expect to head south for a couple of months this winter." Let A. H. Rodriguez know where you are, Al. . . . **Laura** and **Bob Haskell** of Medfield, Mass.,

are planning to attend the Fiesta in Mexico in March. . . . **George Gokey** of Jamestown, N.Y., says that he is "still very much alive and kicking." . . . **W. W. (Bill) Brown** of Cleveland, Oh., reported a planned cruise around South America in January. Write us in detail about it, will you, Bill?

**Mrs. Harry Field** of Honolulu advises that Harry is still in the Arcadia Health Center and would like to see any M.I.T. friends who come that way. Drop him a line at 1434 Pusnahoo St., Honolulu, Hi., 96822. . . . **Glenn Fargo** of St. Petersburg, Fla., wrote that he and his wife took their seventh European trip this past fall and visited Italy, Greece, and France. Will more of you please use the Alumni Fund envelopes to drop a line to your Secretary?

It is with sadness that we report the death of **Arthur R. Harvey** of Middletown, Oh., after an extended illness. He and his wife Ruth were with us at our 50th Reunion. An obituary in the *Middletown Journal* tells of his many philanthropies and his association with the paper industry for 36 years. In 1955, he was named "Boss of the Year" by the Middletown chapter of the National Secretaries Association. A footnote from Wally Adams who supplied the above information, tells that Art had contributed heavily to the construction of a 35-bell carillon in their church and had played the bells himself.

A news item in the December 4, 1972 issue of the *Wall Street Journal* announced the retirement on December 31, of **John W. Barriger**, President of the Boston and Maine Railroad. Are you going to write your memoirs now, John? . . . **Samuel Lunden** reports from California with these two news items. **Ludson D. Worsham** is a Brigadier General, U.S. Army Retired as of 1948. He later worked for the Ralph M. Parsons Co., a prominent Los Angeles engineering firm, and later retired in 1961 as a Vice President. He reports that they have lived in Los Angeles since 1963. . . . **Augustus B. Kinzel** writes, "My two most interesting 'non-profit' activities are the Board of Trustees, California Institute of Technology, and Senior Member of the Naval Research Advisory Committee (one of two Federal Advisory Committees established by Congress). I continue to commute from La Jolla to New York about twice a month and enjoy it immensely."—**Sumner Hayward**, Secretary, 224 Richards Rd., Ridgewood, N.J. 07450; **Josiah D. Crosby**, Assistant Secretary for Florida, 3310 Sheffield Cir., Sarasota, Fla., 33580; **Samuel E. Lunden**, Assistant Secretary for California, Lunden and Johnson, 453 South Spring St., Los Angeles, Calif. 90013

## 22

Pity us poor Buffalonians waiting at Christmas for winter amid 40 degree balmy breezes. Golfers are wearing long-johns and skiers are shedding big, bitter tears along the dry rope tows and slopes. The almanac assures us of cold weather by January 10, to the satisfaction of the photographers who will take pictures of huge drifts about 20 miles south of here

with a Buffalo date line. By then, your Secretary will be calling on Parke Appel in Venice and Frank Kurtz in Del Ray Beach while travelling on the usual Class expense account! Also Catherine and **Dale Spoor** will be driving to Southern California to take a seven-week escorted air tour to the South Pacific and return in time for the M.I.T. Fiesta at Mexico City in March.

**Edward A. Ash** has a new address at 405 N. W. 22nd St., Homestead, Fla., for welcoming classmates. Our Assistant Secretary, **Oscar Horovitz**, will be back at Pompano Beach as noted hereinafter . . . Mrs. and Mrs. **James Keith Macomber** of Centerport, N.Y., were pictured at the Huntington Country Club celebrating their golden wedding anniversary at a dinner party given by their children and grandchildren. Some years ago, Keith became an active consulting engineer following early retirement from the Arma Corp. While at Arma, his inventions related to gun fire and torpedo control equipment. He has recently specialized in automatic machinery and labor-saving devices. He also helped organize the United Fund and serves his church and the Kiwanis Club. We join in good wishes to Mr. and Mrs. Macomber for happy healthful years ahead. . . . **Harold O. Berry** of Taunton is keeping busy with golf and bridge these days while continuing to work at selected hours (his selection.) . . . **Frank O. Ricker** of Jupiter Inlet Colony, Fla., is still happy about the 50th Reunion schedule and his visits with classmates. His daily swim keeps him in good shape and shooting reefs and fish with an underwater camera has become his most rewarding sport. . . . During our Reunion, we received a telegram from **Irwin J. Smith, Jr.**, of Dutch Village, Menands, N.Y., to wish us well. Now he is sorry that he didn't attend.

**Alfred Abboud** tells us that he is recuperating nicely and getting along fine. We were happy to hear from Frances and **Albert Sargent** during their visit at the Hotel Del Coronado while attending a conference of Health, Welfare and Pension Fund Trustees in San Diego. . . . **Raymond E. Miskelly** of Yarmouth Port tells us about his after-Reunion visit by the **George Marvin**s at their home on the Cape before George returned to Ft. Myers, Fla. Ray will be in Florida on Siesta Key at Sarasota for three months

Classes of '19, '20, '21, '22

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starting January 15. . . . **Bryant Essick** of Los Angeles had to miss our Reunion because of a required attendance at the Global Strategy discussions at the Naval War College in Newport, R.I. Since he now owns a brightly colored class jacket, he is looking forward to our next meeting. . . . **Reginald S. Hall** of Norfolk, Conn., has joined others in feeling that conditions and management at M.I.T. are improving. Zillah and Reg are spending the winter in Tryon and will then move to Hendersonville, N.C., at a higher elevation. . . . **Barton Jones** of San Marino, Ca., sends regrets at missing the opportunity of visiting with classmates at the 50th. He tells of enjoying a trip in Bryant Essick's yacht with Don Carpenter some years back and hopes for future visits at the Institute.

**I. R. Loss** of Phillipsburg, N.J., is still enjoying memories of our Reunion in June and the A.O.C. meeting later. He enjoyed the review of accomplishments at M.I.T. and complimented the Class Officers on the convenient arrangements. He has been busy with a chain saw, cutting wood for winter. We note that "he who cuts his own wood arms himself twice." . . . **J. Gordon Campbell** of Southbury, Conn., sent an extra contribution to Dale Spoor for our class fund. He has moved from his place at Pocano Lake Preserve to Heritage Village while trying to keep up with three daughters and ten grandchildren. He hopes to be with us at our next celebration. **Paul M. Kellogg** of Lynnfield Centre has not been well and has moved to the Pilgrim House Nursing Home near Peabody. Our best regards go to Paul and his family.

The sympathy of our Class is extended to the family of **Mrs. William C. Richardson** of Newton Upper Falls; she was Margaret Mall.

Most of our address changes these days are toward the sunny south and many are on a permanent basis. We suggest as our winter activity—a week with the Class of '22 members in Florida by travelling south, down the east coast and then north up the west coast for progressive dinners, probably ending in complete exhaustion, a nervous breakdown and the DT's. . . . You are all welcome to the sailing of the Nordic Prince from Miami on January 13. See you then!—**Whitworth Ferguson**, Secretary, 333 Ellicott St., Buffalo, N.Y. 14203; **Oscar Horovitz**, Assistant Secretary, 3001 South Course Dr., Pompano Beach, Fla. 33060

## 23

We see by the letters from **Rodney M. Goetchius** and **Howard F. Russell** that both are radio "hams." The former, who is our second Vice President, operates to the call sign, K4IAZ and the latter to the call sign W7HHC. Rod tells us that he is now enjoying "a short cold spell" of 47 degrees in Vero Beach, Fla., after a year of almost continuous warm weather. Howard of Sun City, Ariz., lives in a much dryer area, normally, but advises that this year was a real wet one, over ten inches or twice the usual yearly average and all since July. Our experi-

ence tells us that weather is always unusual, therefore always interesting.

**Alfred E. Perlman** has just been made Chairman and Chief Executive Officer of the Western Pacific Railroad Co., succeeding Howard A. Newman. As we know, Al joined Western Pacific in 1970 after severing his association with the Penn Central Railroad where he had been President and Vice Chairman of that troubled merger. . . . **James A. (Pete) Pennypacker** has written a unique book entitled *Cello in Church*. Pete tells us that the rich tones of the cello are particularly suitable for organ accompaniment but that cello music presently available is not properly arranged. Pete's book is ideal for church services of many denominations, in particular, for Christmas and Easter programs. Pete would be glad to supply you with a copy at \$5.35. His address is Long Hill Rd., Essex, Ct., 06426. . . . **Malcolm L. Carey** writes, "Just a word to those of my fellow classmates who may still remember me, to assure them that I am still alive and active. Patricia and I are looking forward to the 50th Reunion." . . . **Robert H. Henderson** writes, "Have been doing a good bit of travel. Spent last year on West Coast of Florida then to Japan and Hong Kong before Reunion." . . . **Dunbar L. Shanklin** writes, "I am writing this on my 68th birthday and am glad to report that I am still working—five months in Florida, three months in Winchester, and four months in Falmouth. My son and I run two companies—one that makes and sells his patented machine inventions and one that formulates and sells my patented chemical inventions." Congratulations "Spider", you are the youngest of the Class! I did a double take when I saw your birth date. It was confirmed in *Technique* 1924!

We are sorry to hear of the death of **Wanton E. (Bill) Gladding** on November 12, 1972. We quote from the Kinston, N.C., newspaper—"A native of Newport, R.I., he was associated with the DuPont Co., for 41 years and served as the first manager of the Kinston Dacron Plant and Laboratory here. His tenure in that post began in 1952 and ended with his retirement in 1966. Quiet and unassuming by nature, Mr. Gladding was a leader who could get the job done because others liked to work with and for him. His contributions to Kinston are many but perhaps his greatest lies in the leadership he offered newcomers with his company to become involved in community services that reflect concerned citizenship." . . . Also we sadly learn of the passing of **Stanwood E. Whitcombe** of Scituate, Mass., on November 14, 1972 and **Gerald L. White** of Montreal, Canada on January 20, 1972.—**Thomas E. Rounds**, Secretary-Treasurer, 4 Deer Hill Dr., Danbury, Ct., 06810

## 24

Although this subject is extraneous to Class Notes, all Alumni must be proud of the superb performance of the Apollo 17 onboard guidance system developed by the Charles Stark Draper Division of the Institute. The touchdown point turned out

to be only 250 yards east and 100 yards south of the landing target put into the guidance computer by Draper lab programmers months before. To determine lunar gravity, the astronauts also used a traverse gravimeter designed and built by the Draper Laboratory.

Class communication between members is increasing, centered around our 50th Reunion and the Siamese project, the 50th Gift. You all received a dissertation early in December from our hard-working President, **Ed Moll**, former executive turned herbalist. He and your escrotaire attended the same fascinating Alumni Officers Conference which Ed summarized with the purpose of informing you that M.I.T. still leads the pack in technical education. You can keep it that way by supporting the 50th Gift to the Environmental Laboratory program. . . . Then followed **Jack** (Reunion Gift Chairman) **Hennessy's** letter of December 14, setting out a number of uses to which funds could be applied. He further suggested that these funds may be available in capital gains from appreciated securities, thus not only avoiding a tax, but magically converting inanimate book figures into real live pesos for the Institute.

**Luis A. Ferre**, Governor of Puerto Rico, received a major setback in his political career when he recently lost his bid for reelection by only 42,000 votes, or 3.7 per cent of those voting. He has constantly worked for full statehood from a commonwealth status. However, his industrialization program has been successful as he has added 1900 factories and 145,000 jobs. . . . Lieutenant General (retired) **James Doolittle** was among the 1972 recipients of the 26th Annual Horatio Alger Award. Jimmie led the first U.S. bombing mission on Japan in World War II. . . . **Paul Blampied**, who gave up driving his own yacht, and left that to the skipper of a Dutch freighter, writes that he and Dot enjoyed last winter's around-the-world trip so much that they are repeating it. "Kind of late in the day to broaden our education, but we find the Far Eastern people fascinating, particularly in Indonesia and Malaysia." (I bet that it broadens other things, also.) . . . **Robert L. Morton, Jr.**, took his senior year with us in electrical engineering, coming from Washington University, St. Louis. He retired from Valley Electric Corp., St. Louis, and writes, "I had a myocardial infarction on May 8, 1972, but recovered fairly well and am now back to 18 holes of golf—walking. Pensacola is a lovely place to live—small enough to get around easily—big enough to have the services you need."

**Reginald B. Miner** seems to have spent his life in the Boston area. He took off from Dartmouth with a S.B. in 1921 and graduated with an S.B. in architectural engineering. In 1928, he went with John Hancock Mutual Life Insurance Co., and retired in 1964 as Vice President in charge of all real estate and mortgage loan investments. He is now a corporator and trustee of Brookline Savings Bank, Brookline, Mass. Reg has always been active in Masonic, Church and Dartmouth Alumni affairs. . . . My weekly reading must is the *Financial World*. In the December 20, 1972 issue, "News and Opin-

ions on Active Stocks" section, "Tishman Realty" caught my eye. It is the common stock of **Paul Tishman's** empire, and is rated B—worth holding for long term growth. They are owner-builders of high-rise office buildings in leading cities.

I close with thanks to my former track associate, **Frank Fricker '25**, who sends a page from the *Naples Daily News* in Florida, of December 7, with a picture of **Lorene and Paul Cardinal** at the presentation of an award to Florida Governor **Reubin Askew**. It is the highest conservation award presented by the Audubon Society. Looking at the picture, I would say that **Hoffmann-LaRoche** should present Paul and Lorene with a suitable conservation award!—**Russell W. Ambach**, Secretary, 135 Aspinwall Ave., Brookline, Mass. 02146

## 25

As the reminder I received from *Technology Review* so often states, that time has come again for another attempt to formulate some Class Notes. Fortunately, I have a number of brief but interesting comments from Class members. **Donald R. Taber** of Holyoke, Mass., reports that he is in fine health and enjoying life. He spends seven months of the year in Holyoke and the rest in Boca Raton. . . . **Harold W. Washburn** of Pasadena, Calif., has been retired from the State University at Long Beach as Professor Emeritus. . . . **John P. Ramsey** comments from Seneca, S.C., on the usual activities of a retiree; a week at Leward Islands last summer and a return to Connecticut for a few days in September. He hopes for a Caribbean cruise this summer.

From Cuyahoga Falls, Oh., **Wade C. Johnson** writes that his health is fair to middling. He summers at Oberlin Beach on Lake Erie and winters at Sanibal, Fla. . . . **Arthur M. Nickerson**, now in retirement at Duxbury, Mass., lets us know that a long-term interest in horology and antique clocks keeps him occupied. He says that he has run the gamut of hobbies during his lifetime and seems to turn his hand at anything except making large sums of money. . . . By the time '75 rolls around and the all-important Reunion is celebrated, I have a feeling that the majority of us will be in the classification of retirees and from all accounts, enjoying it.—**E. Willard Gardiner** (Will), Secretary, 53 Foster St. Cambridge, Mass., 02138

## 26

We are writing on a Sunday morning a week before Christmas so first I'll tell you about Pigeon Cove at this season. It's a blustery morning with the thermometer at 14 degrees. The wind is in from the northwest so we are not getting its full force, and looking out to sea the white caps start at the northern tip of Cape Ann and continue at a 45 degree angle to the shore—at our location they are about a mile off shore. Rockport is extremely picturesque this time of year. The parking meters have been taken from Main Street and replaced with poles that hold Christ-

mas lights. The shops on Bearskin Neck are tastefully decorated and lighted, giving a Dickens era atmosphere. This evening the Christmas pageant will occur as it has for at least 25 years, sponsored by the art association. Starting from the huge Christmas tree in Dock Square, the wise men lead their flock in costume up the hill to the Inn (the Art Association) with a very colorful ceremony. One local animal lover even raises mules to be used at this event.

I'll wager that a few classmates are by now chuckling about their poor shivering Class Secretary and his blustery winter weather. **Bill Edwards** sitting in the Honolulu shade working on his calendar promotion, **Bruce Powers** and **Bill Millar** in the dry warmth of Arizona, **Pete Doelger**, **Ray Mancha**, **Bill Vaughan**, **John Fletcher** and many others at their Florida retreats—but wait! We have just finished talking with our classmate—brother-in-law in Clearwater, Fla., **Win Southworth**, and the temperature there is 34 degrees but due to the population influx a power overload has resulted in a power failure and consequent loss of heat, so don't you Floridians feel sorry for us!

There is a perspective one gets from being Class Secretary of a class that is largely retired and has been for three years. Many of us had a preplanned business activity because retirement seemed to bring with it a kind of crisis that was unpleasant to contemplate. We have had a large percentage of consultants which has been good not only for our classmates but for their companies. We have also had many classmates who have taken to travel by every known means from **Dwight Wood's** trailer treks to **Prince Warner's** cruises and **Peter Doelger's** golf matches. Others such as **Deke Taylor** and **Dave Harrison** have found that large families keep them moving around and occupied, but we note a trend. The novelty or whatever it was seems to be wearing off and many of us have found that retirement isn't so bad after all and are finding ways of freeing ourselves from some of our business activities. Before arriving at this point, I used to be amused at hearing some of my "elderly" friends tell how busy they were. Now it appears quite simple. How many things there were that you always wanted to do or read but they were always put off. Now that there is time, the list is still longer than you can possibly handle plus there is no one to delegate minor time-consuming duties to—and it's not bad, is it? It's a pleasure talking with our '26 family and many others who for some unknown reason seem to like to spend time with us. So until the M.I.T. Mexico Fiesta in March, Cheerio from Pigeon Cove.—**George Warren Smith**, Secretary, P.O. Box 506, Pigeon Cove, Mass. 01966

## 27

**Dick Cheney** writes a chatty Christmas Card telling me that he and Orissa are thoroughly enjoying Santa Barbara. He now has three clients: Glass Container Manufacturers Institute; National Center for Resource Recovery; and a Mexican company, Tubos Internacional S.A. Be-

sides his consulting work, he keeps busy on the Board of Santa Barbara Beautiful, is an advisor to the Director of Development of U.C.S.B. on business and industry, and on community relations, and still finds time for a little golf and horseback riding.

**Ed Chase** and **Larry Coffin** are also using their accumulated experience as consultants. **Ed** retired recently as Supervising Civil Engineer for the Massachusetts Dept. of Public Works and is doing part-time consulting in his home town of Plymouth. **Larry** is business consultant to Administration Rodgers, superintendent of the Maine Maritime Academy, and has also been appointed by Governor Curtis to the Mark Maine Committee, encouraging economic development. . . . **Ann and Joe Harris** have wanderlust again. Two years ago, they took a cruise to the Orient on an Orient Overseas Line cargo liner, and last month (January) they were scheduled to sail again to Hong Kong, where they are again planning to see **Wally (We-Tu Kwauk)**. In between, they had a long tour of Europe. **Joe** sends me also a clipping from the New London newspaper of November 24, reporting the destruction by fire of the house on Whale Oil Row owned by **Dr. Carl H. Wies**. **Carl** had to fight the New London Redevelopment Agency a dozen years ago to save his house (and three others on the row), and finally had it declared a historic landmark. He had completely rebuilt and refurbished it, and after the fire announced that he would again restore it to look like the original building. **Carl** has been practicing in New London for 36 years.

**Elmer Andrews**, who retired from Eastman Kodak in 1967, now has six grandchildren, four of whom live nearby in Penfield, N.Y.; the other two are in Columbus, Oh. He and **Vara** do a great deal of travelling and keep busy with gardening and church work. . . . **Charlie Sanborn** had a bout of diabetes acidosis which kept him from the Reunion and took more than 20 pounds off his weight, which he has not regained. But he tells me that he is now getting along very well.

The heartfelt sympathy of the Class goes to the families of **J. Sellers Bancroft**, who died on April 26, 1972, and **William J. Rudge Jr.**, who died on October 30. **Bancroft** spent his entire busi-

Classes '23, '24, '25, '26, '27

## MINI-REUNION

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ness career, from 1927, with the Wilmington Trust Co., of Wilmington, Del., achieving the rank of Vice-President. Bill Rudge retired in 1965 from General Electric, where he was Manager of the Distribution Protective Department. He was a Fellow in the Institute of Electrical and Electronic Engineers and was elected to the Duke University chapter of Tau Beta Pi in 1954 as an "eminent engineer."

I have been flattered by notes from a number of classmates since taking over the job of Class Secretary from Joe Harris. I am grateful for the good wishes but I appreciate even more those which manage to add a bit of printable news.—**J. H. Melhado**, Secretary, 24 Rodney Rd., Scarsdale, N.Y. 10583

## 28

In case you have not yet marked your new calendar, we suggest that you promptly reserve the dates of Friday, June 1 to Sunday, June 3, 1973 for our 45th Class Reunion at Bald Peak Colony Club, Melvin Village, N.H. On the following day, Monday, June 4, the annual M.I.T. Homecoming will be held at the Institute in Cambridge. This you will also want to attend, perhaps on the way home.

We have a good collection of short notes, thanks to Alumni Fund envelope panels. **James Rae** reports: "Having reached age 65 and after 44 years of service with A. T. and T., I have now retired. For the past ten years I have been heading the engineering department of Long Lines." . . . **Joe Riley** says: "We have returned to Florida from another summer on Cape Cod and are gradually getting accustomed to the heat and humidity. Please tell Jim Donovan that we will be back up north about May 1 and look forward to being at the Reunion."

. . . **Doug Tooley's** message was brief and to the point: "We plan to spend Christmas in New Zealand this year." . . . Our Class traveler, **Des Shipley**, put a lot of information into a very few lines: "We did the Orient this summer starting with Bangkok and working homeward. Things are reasonable in Bangkok and Hong Kong. Floating markets in the former and the beauty of the latter impressed us particularly. In Taipei, Taiwan, things start to get expensive and by the time you get to Japan the cheapest dinner is about \$10 and only fair. The inland sea, Kyoto, Hiroshima, Beppu and of course Nara were very interesting. Then we should mention the Bullet Express which does 130 miles per hour. We rested up in Hawaii after all this."

**Henry Conroy** wrote: "I have been retired since 1970 but working part time as consultant on the building program of Memorial University of Newfoundland. I play golf whenever possible." . . . **Charles Topping** says he is still active in the building program at Swarthmore and "having a ball with a series of new improvement projects." . . . **Charles Ricker** reports: "I retired from Chicago Transit Authority as Chief Equipment Engineer on April 1, 1972. I was 65 on September 2, 1971 but had a six-month extension." . . . **Dud Collier** has been traveling again and says: "My wife, daughter, and I had

a wonderful nine-week trip to England, Scotland, and Wales last summer. We crossed over on *Queen Elizabeth II* and returned by B.O.A.C. In London we enjoyed some good shows, a hydrofoil trip to Greenwich, Windsor Castle, and then the cathedrals and castles throughout Great Britain. Daughter Jill took in a math conference at Essex College and we visited my wife's relatives (30 of them)."

From **Roger Pursell**: "We have been enjoying retirement for the past four years and have done considerable traveling in the past year. We have just returned (November) from Japan, Southeast Asia, and Hawaii. Last spring we visited Greece, Turkey and Italy. Now we look forward to visiting other countries next year." . . . During a recent telethon session at M.I.T., **Jim Donovan** jotted down the following bits and pieces of information: Louise and **John Reynders** spent three weeks on the Algarve in Portugal last summer. . . . Lela and **Walter Nock** are proud grandparents. . . . Maxine and **Karl Otte** are coming to the Reunion as well as **Stan Humphrey**. . . . Janet and **George Hubbard's** son Bob is Chief Engineer at one of the Alcoa plants, son David is a chemical engineer with Procter and Gamble, and daughter Nancy's husband is a career navy captain on a Polaris submarine. . . . Helen and **Bob Murphy** are planning on Bald Peak. Bob is still busy professionally. . . . **George Mangurian's** wife, Peggy, talked with Jim, who not only got himself a date to dance with Peggy at the Reunion but assurances that George would be there at the piano to play for us. George's piano music has become an expected part of a '28 Reunion. . . . **Chet Day** and his wife have retired to Damariscotta, Maine. Chet wants to hear from **Al Carey** and **Jim Rae**. . . . Both Jim Donovan and **Charlie Worthen** received notes from **Max Parshall** who reported that his wife Mary had suffered a severe heart attack while she was on a fishing trip with Max. She spent a week in the hospital but is home now (December) and improving slowly. Mary was well enough to send Frannie Donovan a cheerful letter expressing hope to be with us at Bald Peak in June. . . . Kathleen and **Bob Larson** say that they plan to be at the Reunion. It appears that Bob has no intention of retiring. . . . An M.I.T. bulletin of September 15, 1972 announcing various staff appointments includes **Robert Woodbury** as Professor in the Department of Humanities.

We regret to report the deaths of two classmates. **Joseph R. Kendall**, Course VI, died on August 12, 1972. Bob, as he was known to his friends, was electrical design engineer for New England Power Service Co., in Boston. He retired in 1968 after 40 years of service with his company. From his wife, Viola, we learned that Bob's death was the result of a brain tumor. He had been very ill for about a year.

Classmate **John A. Kelly**, Course II, died on February 8, 1971. This information has come to us belatedly and we have no details at this time.—**Walter J. Smith**, Secretary, 209 Waverly St., Arlington, Mass. 02174

## 29

**Amasa G. Smith** of Birmingham, Ala., writes, "Since retirement, I have managed to keep busy—sometimes too busy and all for free. I am active on Boards of: Boy Scouts, Girl Scouts, Y.M.C.A., and the Downtown Club. I also serve on Boards of Birmingham National Bank, the National Woodworks, Blue Cross and Blue Shield. As an interested member of the Class of '29, I want to thank you for the good work you are doing for our Class." Mace was also co-chairman of Birmingham Business and Industry for the Re-election of President Nixon. In recognition for 42 years of meritorious service with the Chicago Bridge and Iron Co., an oil portrait of Mace was unveiled at a family-day open house at their plant on September 26, 1972. Attention to golfers! Mace had the good fortune of scoring a hole-in-one on the ninth hole of the Birmingham Country Club's east course. It was his first ace in 40 years of golfing.

**Ross M. Pfalzgraff** of Swarthmore, Pa., whose death was reported in last month's *Review*, was the retired chief engineer of American Viscose Corp. After retirement, he was engaged in consulting work and was connected with Rust Engineering Co., of Pittsburgh. He was a recognized authority in his field in many foreign countries as well as in the U.S. He was a member of the Union League and the Engineers Club in Philadelphia; the American Institute of Electrical Engineers; National Society of Professional Engineers; and the American Society of Metals and Army Ordinance Association. He is survived by his widow, the former Dorothy More and a son Ross, Jr., of North Carolina.

**Richard K. Opper** of Walcott, Conn., has retired as of October 1, 1972 at the age of 65 with 43 years of service with the U.S. Rubber Co. Currently, he is President, Naugatuck, Conn. Y.M.C.A. and President of Wolcott Historical Society. He lives alone in a ten-room house built in 1970 which is filled with antiques (none for sale). He is still single; with such a hobby as collecting antiques, he says he can't afford to get married. . . . A brief note from **Richard C. Wood** of East Hampton, N.Y., reads "Enjoying life as a residential architect in this beautiful village." . . . **Jarvis M. Hazard** of Bellerose, N.Y. states in his note that after retiring in 1970, he started to read some new books on solid-state electronics which rekindled his interest in it. He is now working in that field again. "My advice is" he says "Never retire. I still keep my hobbies."

**Leonard C. Peskin** of Wyncote, Pa., is currently Chairman of the Board, Thermal Research and Engineering Corp. (Division of Cardon International). He is active only on special assignments, which have taken him to Tokyo and Milan this year. His son Richard is Professor of Mechanical Engineering at Rutgers University and his other son, Henry, is an economist in Washington, D.C. . . . A note comes from **Wade H. Shorter, Jr.**, of Saratoga, Calif., as follows: "Thanks for the birthday card. Right after that big event, I was retired from F.M.C. Corp., in

San Jose, Calif. I expect to do a little consulting, traveling, gardening and some social drinking." . . . **G. Robert Orrill** of Hot Springs, Ark., has just purchased a retirement home in his area consisting of six rental units plus his own apartment. He has been upgrading by making improvements and plans to manage it as his retirement occupation. He says he never worked so hard in his life before he tackled this job. . . . **Donald Hersey** of East Hartford, Ct., has retired from Pratt and Whitney Aircraft (Division of U.A.C.) engineering department as of 1967; and is enjoying the peace and freedom of it. He is devoting some of his time to the serious study of art (painting) and music (piano). His hobbies include golf, hiking, boating, fishing and other outdoor sports. He is also doing some traveling when the weather and the mood is receptive. "Since we are within visiting distance of our children and grandchildren" he concludes, "we have remained in our home of 30 years here."

**Thomas W. McCue** of Newton Highlands, Maine, is presently connected with two publications, one dealing with the plumbing industry and the other with fire-fighting equipment by selling advertising (mostly in New England and some nationally). He is also an assistant at the library of the Chamberlyne Junior College in Boston, Mass., where he took some business courses from 1964 to 1965. He has also taken some courses dealing with cancer research at Boston College Evening Division. . . . **Paul S. Kingsley** of Richland, Washington, writes, "in 1960, I went in the hospital for open-heart surgery, but developed an embolism, so they were unable to finish the job. Since then I have had to lead a greatly restricted life. I did put in five more years on the job with General Electric's Hanford Works. Since then, I have done part-time consulting work with Atlantic Richfield and Babcock and Wilcox. My son is also a chemist in the atomic energy field, and works for B. and W. in Lynchburg, Va. There isn't an alumni group here nearer than Seattle, although I am sure there must be many M.I.T. men with the various Hanford contractors. We are seriously considering moving to Florida, California or Arizona. Winters here used to be mild, but it hasn't been over 32 degrees since Thanksgiving, nor over 10 degrees for the past ten days. Too cold for senior citizens."

**Edward R. Godfrey** of Huntington, N.Y., writes that he is enjoying his retirement which started four years ago. The Godfrey's enjoy their summers, cruising the east coast from Long Island to Maine. They spend winters at home to catch up with work that has to be done and manage an occasional tropical junket. They also claim to be expert grandchildren sitters. . . . **J. Sarto Nadeau** of Montreal, Canada writes, "After M.I.T., I obtained my B.S. at Geneva University in Switzerland. I got married in 1934 and we have two daughters. I had been employed by the Imperial Oil Ltd. (subsidiary of S.O.N.T.) from which I retired after 34 years of service. At the time of my retirement, I was Assistant Manager of Marketing Operations in the Province of Quebec. Although I have a few health

handicaps, I still feel good enough to enjoy life. We are planning a six-week trip to Costa del Sol in Spain starting in February." **Editor's Note:** With apologies for error in December Notes to Walter H. Partridge "retired this week from U.S. Marine Corps . . ." should read, U.S.M. Corp.—**Karnig S. Dinjian** Secretary, Starlight Towers, Apt. 14E, 6000 N. Ocean Blvd., Fort Lauderdale, Fla. 33308

## 32

**Manson Benedict** has been selected to receive the Atomic Energy Commission's Enrico Fermi Award for 1972. President Nixon has approved the recommendation of the Commission and its General Advisory Committee that the prestigious Fermi Award be conferred on Dr. Benedict. He was one of the principal designers of the nation's first gaseous diffusion plant at Oak Ridge, Tenn.; has made major contributions to the development of the nuclear reactor for commercial power in the United States; and has provided the leadership for the establishment of a preeminent school of nuclear engineering at M.I.T.

**John W. Leslie** was recently honored with the army's highest civilian award, the Decoration for Exceptional Service. The medal and citation were awarded by Secretary of the Army Robert F. Froehke and the citation reads in part, for ". . . distinguished leadership, superior expertise, and extraordinary professional skill. . ." over a 13-year period. John is Chief of the Engineering Division of the U.S. Army Corps of Engineers in Waltham, Mass. . . .

**Herbert H. Uhlig** was recently appointed Professor in the M.I.T. Department of Metallurgy and Materials Science. . . .

**Ray Hawksley** rejects even the idea of retirement and has informed us that he has recently added a new building to house more water pollution laboratory equipment and a staff to handle a 400 per cent increase in work . . . **Samuel E. Paul**, M.D., advises that he is completing his last year of residency at the U.C.L.A. Neuropsychiatric Institute. . . . **Russ Robinson** and his wife, Sylvia, are leaving Connecticut to escape the New England winters for the warmer climes of Tucson, Ariz., where they hope to join some old Byrd Expedition buddies in desert living. . . . **Robert S. Prescott** writes to confirm an enjoyable time at the June Reunion and hopes to find some sunny weather for his vacation in Arizona. . . . **Milton S. Hathaway**, who retired from Atlantic Richfield in 1969, is now headquartered in Dallas, Texas as Chief Geophysicist for Inlet Oil Corp. . . . **Rolf Eliassen** has been elected to the Board of Directors of the High Voltage Engineering Co., Burlington, Mass., in addition to his duties as Vice Chairman of the Board of Metcalf and Eddy, Inc., Boston, Mass.

**Gaynor H. Langsdorf** retired last June 30, after 38 years with Standard Oil Co., of California, involving an interesting career from job engineer in the Richmond Refinery up through Vice President of Oronite Chemical Co., a subsidiary, and a final assignment as Manager of the Office

of Executive Development. . . . **G. Robert Klein**, in addition to his duties as President and Chief Executive Officer of Klein News Company in Cleveland, Oh., keeps active in community affairs as Vice Chairman of the Board of Trustees for St. Luke's Hospital, Trustee for the Musical Arts Association, and Trustee for the Cleveland Playhouse Theater. . . . **William S. Clark**, after working several years on airplane specifications for North American Rockwell, has joined the Public Works Department, State of Ohio, in water control work on canals for industry and municipalities.

I am sorry to announce the passing of **F. Francis Donoghue** of Worcester, Mass., on October 27, 1972. He had worked as a research engineer at the Draper Corp., Hopedale, Mass., and retired in 1965.—**John W. Flatley**, Secretary, 6652 32nd Street N.W., Washington, D.C. 20015

## 33

First billing this time goes to **Niaz Mostafa**, (Musty to you), who writes from Cairo, saying "We have finally decided to come to the 40th Reunion, and are extremely happy for this decision." All three of the Mostafa children were educated in the U.S. Son Hatem is an M.I.T. man, '63 and is working in Toronto with the Foundation of Canada. Nadia has a master's from Columbia, and is teaching in a Cairo suburb. Adel is a graduate of California Polytechnic, and is working at the Mostafa fruit farm near Cairo. Musty is in construction work in Egypt, and elsewhere, and at present is working on water and sewage pumping, and in water purification. His firm also represents foreign firms like General Motors and Cyanamid, and also represents foreign engineering for German and Swedish firms in contracting. Musty deplores the unhappy political situation in the Near East. He would like to take it easier, but does not know what he would do with himself if he did. Leona and I well remember Musty at the 25th, as he and his family occupied the next seat to us on our bus ride to Ipswich, Crane estate. Now the kids are all out of college and married. This man will travel thousands of miles to take in the 40th, showing what can be done when one really means it. Musty, we all appreciate your fine letter, many thanks.

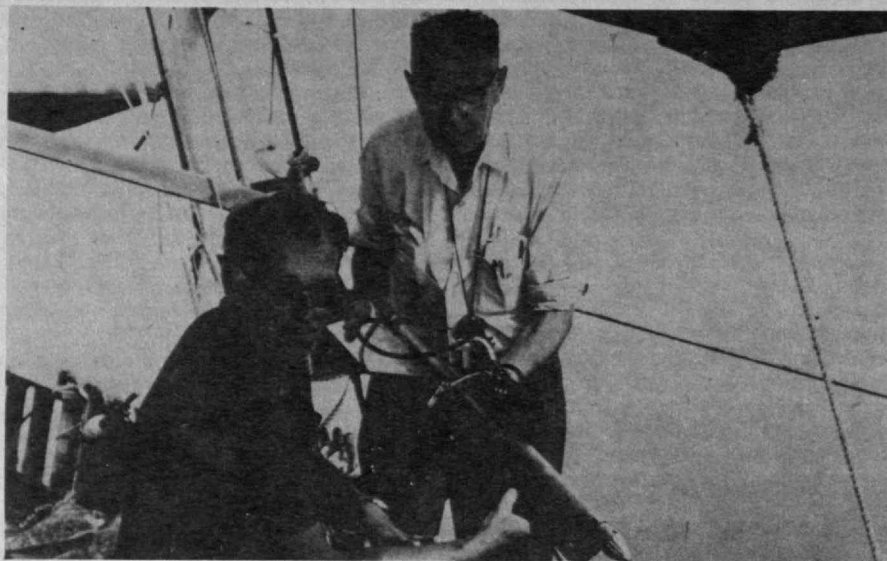
Classes of '29, '32

## MINI-REUNION SUNDAY, JUNE 3RD

Directly preceding  
International Buffet,  
Boston Pops.

## ALUMNI DAY JUNE 3RD & 4TH

Send in coupon at end  
of class notes **NOW!**



Three methods of underwater wreck detection were used by Harold E. Edgerton, Sc.D.'31, Institute Professor Emeritus, and oceanographer Peter Throckmorton (left) last summer to search for remains of the Lepanto naval battle off Greece: a side-scan sonar

(above) with a narrow beam, a 5-kHz. sonar to penetrate bottom sediments, and a magnetometer to detect the presence of iron. Though many targets were recorded, the first efforts did not reveal the site of the battle itself. (Photo: EGG Ink from EG&G, Inc.)

## Many Targets, but the Wrong Ones . . .

To travel from Italy to Athens (Peiraeus), you must sail through the Gulf of Patras, off Peloponnesus. So it was 400 years ago, too—hence the importance of this waterway to the ancient world.

And hence the presence there last summer of Harold E. Edgerton, Sc.D.'31, Emeritus Institute Professor who is generally recognized as the "father" of high-speed strobe photography, on board Peter Throckmorton's ship *R/V Stormie Seas*. In a three-week survey sponsored by the National Geographic Society the expedition found at least five "modern" wrecks (less than 100 years old) and "numerous other targets (per-

haps Phoenician, Greek, Roman, or even Bronze-Age vessels) . . ." All were located on charts to serve as the subjects for later investigations.

But the primary target remained elusive. *Stormie Seas* was looking for the site of the Lepanto naval battle of 1571, when a Turkish fleet and ships from Venice, Spain, and the Papal States suffered combined casualties of more than 15,000 men and perhaps hundreds of vessels. If, as accounts suggest, the battle occurred in the middle of the 200-ft.-deep bay, sediments accumulating at the rate of perhaps 2½ ft. every 1,000 years will have covered the sunken ships, an archeologist's treasure, and preserved their remains.

**George Henning** came through with his bit, by phoning our Florida home in July; seems he and Lucy were attending some banker's convention in the Boca Raton Hotel, and hence the phone call. Frank Carey, our son-in-law, was at the house on his regular inspection tour, so George found someone home! Now comes a card, to wit: "Lucy and I stopped at the Florida house and found house magnificent; pool beautiful; lawn green; window washing unique; beach clean and broad; Whiskey cartons MT; doors locked; door bell, no reply." Now, for the record, George gets a Spec. I wish I had been home, George and Lucy.

**Clarence W. Farr** retired from the MITRE Corp., November, 1971. The Farris must have gotten tired of rebuilding an old house near Nashua, and have moved to the city, itself. March, 1972, saw the birth of a new Farr real-estate venture, husband and wife team. Hope it goes well, Clarence. . . . **Mort Williams** and wife made a visit to the Farris in October, last. Mort is still with DuPont in Houston. Thanks, Clarence, and don't forget the 40th (Reunion and Fund.) . . . **Bill Conant**,

writes from Wilmington—no national honors for Bill, but he was honored for his long term on the DuPont Golf committee, and, his "finest hour" came with a digital clock, suitably engraved, for his work on the employee relations Golf Committee. Good wife, Theo, is still busy with community and church affairs. Son Roger, 28, is a stock broker with a large firm. Daughter Marsha, 25, has just received her master's in psychology. Bill intends to retire at the end of 1972. Then comes a great chance to travel, and more leisure to work at the many things they like to do, such as golf. As an aside, Bill, Dr. **Bill Harper** fears that he probably won't make the 40th because of too much to do keeping his college afloat. Why don't you get after him? He never did pay much attention to me.

As announced here, earlier, **Charlie Bell** lost his Helen a year or so ago, and admittedly, he was a lost soul. So, in April of this year, Charlie remarried, and is happy. He tells us that Jane is an old friend, and is tops, as we will see at the 40th. Further, the Bells have acquired a trailer, and are "roughing it". His

daughter, Nancy, lives in California, and has three children and about to adopt the fourth. Daughter Susan, lives in New Orleans, and they have two kids. Son David, is an M.D. and still in training in Boston. Emily, is a senior in high school, and is preparing for college.

We would like to add that **Charlie Bell** has been a tireless worker at most of our former reunions. Many good jobs have been done since, but none better than those old Charlie did in the past.

One of our less voluble fellas comes through with a bang. "**Bob Seyl** continues his own enterprise in Research and Development operations on methods and devices for instantaneous corrosion rate measurement of metals in non-gaseous ionic conductors, with progress measured in part through issued patents, and some pending." Bob also says that at some later date, it is possible that elaboration on the highlights of this operation might be of interest to others. Bob, may I suggest that you consider a paper, or have this elaborate item published. I fear that it might not belong here. Bob and Margaret are apparently well, and are on their 31st wedding bit, as opposed, admittedly, to our 50th. It appears that Bob got a late start, and I got an early one. So, we congratulate each other.

**Stan Walters** comes through with his bit per request, and does very well. Just leaving for a sales conference in N.Y.C., Stan feared that he might forget, so wrote under some pressure. First, he takes credit for giving Clarence Farr (above) a tip that a friend had a house for sale, and, sho 'nuff, Clarence came thru and did sell it, and Stan avers that come June 1973, Farr will owe him exactly one drink. I'd ask more than that! You will recall that Stan is very active in local town affairs, so it comes with no great surprise that Stan got into the act when they built a new road west of East Sullivan, N.H. Stan's bit was to sell them most of the sand and gravel from his ranch nearby. Anyway, Stan was able to capitalize on this further by having real foresight. Before they took out the gravel, Stan had borings made, and discovered a blue clay bank under the 20-foot gravel bank. So, it appeared to be easy to bulldoze the clay into a dike, and get a full-acre recreational pond. Stan says that the water is better there than anywhere else, and he suggests that all '33 men (and women) visit East Sullivan, and take advantage of the excellent swimming. Stan closes with a short bit on his activities around the ranch, landscaping, wood lot thinning, and kindred work. He is still very active in his sales work around New England. Many thanks, Stan.

To honor a promise, I cannot close without a mention of the 40th Fund. We are not over the top. It will take the generous help of many who have not contributed, or have not contributed enough. Things look better at M.I.T. I am informed, but we are not out of the woods.

No address changes this time around, as I am writing a little early. They will catch up, and appear in March. We are saddened to hear about another classmate, **Robert C. Richardson** who passed away in October. We have nothing so far but that bare fact, so no details. He was



Here, from left to right, Walter A. Rosenblith, Provost, Jerome C. Hunsacker, Professor Emeritus of Aeronautical Engineering, (Dr. Hunsacker was Chairman of the Department of Aeronautical Engineering when Dr. Spilhaus earned

his M.S. at M.I.T. in 1933); Dr. Spilhaus; Alfred A. H. Keil, Dean, School of Engineering and Director, M.I.T. Sea Grant Program; and Robert B. Abel, Director, National Sea Grant Program.

### Sea Grant Presentation

The M.I.T. Sea Grant Program presented a plaque to Athelstan Spilhaus, '33, Fellow, Woodrow Wilson International Center for Scholars, to commemorate his lecture as the First Annual Sea Grant Lecturer. Dr. Spilhaus spoke at the Convocation which marked M.I.T. Sea Grant's first Institutional grant, September 27, 1972. The Sea Grant Program plans the Annual Lecture as a yearly milestone in the marine field, an opportunity for the Lecturer to review current problems and to present perspectives for the future. The Program dedicated the Lectureship to the study and to the evolution of major national and international opportunities and to the identification of inventive approaches to pursuing these opportunities. "We hope it will be a na-

tional focus for all persons interested in and working on marine and marine-related problems," Dr. Keil said at the Convocation.

M.I.T. is now a Sea Grant Institution. The National Sea Grant Program (National Oceanic and Atmospheric Administration, Dept. of Commerce) awarded the grant to M.I.T. July 1, 1972. This grant is a direct outgrowth of M.I.T.'s two-year coherent area project, "Ocean Utilization and Coastal Zone Development." This grant supports research, interdisciplinary education and training, and advisory services on problems of sound ecological ocean utilization and coastal zone development that concern Massachusetts, New England, and the nation. MIT's institutional program includes 20 research, education, and advisory services projects.

one of our own Course II men and we wish to assure that the sympathy of our entire Class goes to Bob's surviving loved ones.

The 40th Reunion at Chatham Bars Inn is shaping up to be one of the biggest and best in history. You have received one mailing and will be receiving another in mid February. Please send your intentions to **George A. Stoll**, RFD 3, 45 Taylor St., Pembroke, Mass. 02359, Registration Chairman. Best regards and greater happiness.—**Warren J. Henderson**, Secretary, 1079 Hillsboro Beach, Pompano Beach, Fla. 33062

# 34

Most of this month's notes came through your responses on Alumni Fund envelopes. While they tend to be brief, they are most satisfactory since they are specific evidence of your continued support of M.I.T.

**O. Edward Cantor** says, "I am very

sorry to report that my wife Frederica (Olsson) died September 20, 1972. We had been married July 5, 1935 at Cristobal, Canal Zone. We have three children: Carole—now working toward a doctorate at Duke University; John—working for General Electric in Philadelphia; and C.W.C. III—now in the army. John has two children, a boy and a girl, making me a very happy grandfather. I will retire in 1973 and return to the U.S." I was particularly sorry to read of Connie's loss—I can't remember how, but I had met and known "Freddy" during my first year at Tech. We all sympathize with him on his loss.

**Oleg J. Devorn** writes, "Well you may state, if so desired, that I have retired. Intend to stay here in California. No more travelling. Am in excellent health. Have a house with a swimming pool and am enjoying myself to the hilt." Since California seems to be one of the places people head for on retirement, Oleg's decision to "stay put" seems like a real sensible one. . . . One of the ones still working is

**John C. Hawkins** who says, "After 24 years with the same company, the last four years find me involved in the sales effort to the mining industry. This has been a very fascinating change from the chemical industry I worked with for the first 20 years. However, as a Course X graduate, I sometimes wonder if I should have listened to Professor Hamilton when he was trying to get some of us to 'switch.'"

. . . It is obvious that **Harold C. Leighton** can't quite shake the yankee feeling. He writes, "Every year on our way to our summer home in Cape Elizabeth, Me., I promise myself I'll stop for a day to visit the school again, but am too anxious to get some of that good salt air! Have made my living in Ohio for 35 years, but there is a lot of New England in me yet. Our daughter, Elizabeth (Mount Holyoke, '71) will get her master's in Classics at Columbia in December—then on to a teaching fellowship there." Harold, if you really haven't seen the Institute for any real number of years—find time for a look. Just the physical changes will amaze you.

**Herb Plass**, a faithful Reunion attendee, sends one of the most glowing notes I've seen in a long time. He says, "I have finally achieved one life-time goal: Promoted to Clinical Professor of Medicine at the University of Minnesota Medical School. The title is purely honorary. I teach medical school sophomores, juniors, seniors, interns, and residents, four quarters per year. All for a title—no pay. I am expected to earn my own living in private practice (which I do.) The title tells you this: Clinical Unpaid Professor. The clinical unpaid staff in our medical schools now outnumber salaried staff and we are given the task of teaching the young ones how to take their theories to the bedside and treat sick people. Wonderful life for me." And wonderful that Herb feels that way about it. . . . George Bull's wanderings struck at least one responsive note as witness the following from **William L. Timmerman**. "My wife Anna and I have three children; Carole Belcher has presented us with two delightful granddaughters; Arthur is married and a photographer; Laura is a junior at Mount Holyoke with an interest in sculpturing. Happy and thankful with it all, but still a little envious of George Bull and his wanderings."

Class of '34

## MINI-REUNION

SUNDAY, JUNE 3RD

Directly preceding  
International Buffet,  
Boston Pops.

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JUNE 3RD & 4TH

Send in coupon at end  
of class notes NOW!

My last note is a sad one, one that a number of us around Boston have been afraid of for some time. **Carl Wilson** writes that his wife Muriel died April 5, 1972 after a long illness. If I remember correctly, Carl and Muriel were not able to make our last Reunion because of her sickness—so it has been a long struggle. We can only extend our sincere sympathy to Carl for his loss and problems through a long and trying period.

We are reminded again that the years are passing with a notice from the Institute of the retirement of two members of our Class—**Joseph Bicknell** and **Walter McKay**. By coincidence, both of them were Professors in the Department of Aeronautics and Astronautics. . . . You may recall that about a year ago I mentioned visiting Winnie and **Ted Taylor** in Kittery, Me., and telling how their land had been chopped up to make way for the new I-95 and its bridge. In this year's Christmas card they told of almost losing their house in a fire in May. It apparently started in the garage, spread to the kitchen and pretty well ruined the living room before being brought under control. They say they have it back together but there must be many things that just couldn't be replaced. The house is one of the lovely old square New England homes. Ted and Winnie were leaving again for Mexico, where they have spent the last several winters.

My last item is a note from **Jim Eder**. He says "Mary and I, after seeing you at the Alumni Officers Conference in October, saw Sherry and **Earl Murphy** in Jesup, Ga. They didn't clue us in on how all their children managed to attain the goals we at school sought: top colleges, top students, exciting and worthwhile work, and thoroughly happy and well adjusted. Hard to believe these days. Earl took full charge of designing their local church and did a beautiful job for a small cost. As chief engineer for I.T.T.'s Ray-oneer Division of everything east of the Mississippi, he thought he had to tackle a job in England. His personal planning for the trip was extensive, so when the job fell through, he and Sherry went there anyway and had a wonderful vacation." —**Robert M. Franklin**, Secretary, Satucket Rd., Brewster, Mass. 02634; **George G. Bull**, Assistant Secretary, 4961 Allan Rd., Washington, D.C. 20016

## 35

A sad note from **Ollie Hoag** told of the death of his wife, Lucile, on October 12 after a three year bout with throat cancer. Their children gathered from Brazil, Colorado, and California. Our deepest sympathy goes to Ollie. His address: Overlea Rd., North Bennington, Vt. 05257. . . . We are also sorry to report the death of **William D. Kiebler**, one of the Course IV men in our Class. His home address was 5774 Berkshire Lane, Dallas, Tx. 75209. He died September 30. I extend our sincere sympathy to his widow, Mary Elizabeth and sons, William C. and Robert.

Barbara Anderson, wife of **Arthur R. Anderson**, wrote an interesting little note from their home in Tacoma, "Do you know

that Richard G. Anderson, who received his M.S. in Civil Engineering, is the great-grandson of Charles W. Hinman, Class of 1870, the grand-nephew of Walter H. Hinman, Class of 1899, and the son of Arthur R. Anderson, '35?" . . . **Herbert Small** writes from Green Valley, Ariz. near Tucson. "I enjoy my life in this retirement community. Bat circa 5 per cent at the chess club. Am trying to up-date my bridge; enjoy the swimming pool, bird watching and going to concerts."

. . . **Stan Alexander** writes, "Continuing full-time activity in real estate as an associate of Barbara M. O'Brien, Realtor, Lincoln, Mass. Recently attended Course II of the Realtor's Institute of Massachusetts." . . . From Cincinnati, **Philip H. Rhodes** writes "Still holding my own in work and play. Continued effort in various polymer additives a.b.d. stabilizers in Organic Division at Emery. Oldest grandson is scheduled to enter S.M.U. next fall (Phil III). Phil Jr., got M.B.A. at S.M.U. this past Spring. Spare time spent in keeping up old 15-room house and gardens where Lillian and I just rattle around." . . . From the ebullient **Jack Holley**, "Hi Everybody: Had my 60th birthday—not a unique experience for '35ers, is it? But what a party. Among the dishes (other than the ones in mini skirts and hot pants) were 'pansit', 'dinuguan', 'adobo', 'lumpia,' and 'valenciana' wumpff! Anybody making it out our way is invited to dinner." Out our way is: Vista Calif., a San Diego suburb.

Dot and **Arthur Haskins** wrote a note just before Christmas as follows: "Still here at Bath Iron Works, Supervisor, New Construction Estimating. Had a part in helping to create the present 235 million dollar backlog. Big expansion by up-grading of facilities is now going on. Largest level luffing crane in the western hemisphere—200 tons—will serve three shipways. It is so large it takes up a complete shipway with its rails and all. Carol was married in June and is now Mrs. Wayne Roth. They live in the Denver area. Just moved into a new condominium with fabulous view of the mountains. Dan still teaches Mechanical Engineering at Franklin Institute, Boston. Dot and I hold the fort by ourselves most of the time. Bought a three-year old 30-foot cruising boat last Spring. Didn't win any races but found her to be a fine improvement over my 27-footer for cruising."

I am also giving you some paragraphs from Helen and **Sam Brown's** Christmas letter, "Our Don and Dot welcomed the arrival last May of their first son, Daniel Preston, born on his mother's birthday, May 30. With two girls, their household is constantly busy. Fortunately, they still live in Somerset, N.J., and we see them frequently. Joan and John still live at Ann Arbor, Mich. John is teaching math at the University and doing research for his Doctoral Dissertation in Algebraic Topology. We had a few short trips this year: to Florida and Puerto Rico during the winter and we spent a few days on the Gaspe Coast in July. We played quite a bit of golf separately and together, even though our summer season started late because of record rains. In early December we plan to be at Palm Springs." And I am sure the golf was

excellent.

Class President, **Bob Forster**, is putting together all the material he received on his questionnaire and will have a report for these notes very soon. In the meantime, if you live in snow country, don't give up hope, you have only another six weeks. Snow country is where snow-mobilers in late April are groaning as they say, "well I suppose we are going to be in for a long hot summer." Come out from hibernation and write to—**Allan Q. Mowatt**, Secretary, 61 Beaumont Ave., Newtonville, Mass. 02160

## 36

Almost every list of address changes shows a move to Florida. The most recent is that of **Ronald Beckman** from the Washington area to Marathon. As I gaze at the drifting snow I occasionally envy them. . . . The Kendall Company has announced the appointment of **Karl Gelpke** as Assistant to the Vice President of Research and Development. . . . With his contribution to the Alumni Fund, **Laddie Reday** writes that he sold his company and took a trip to Russia this past summer. On his return he formed Western Water and Newport Properties to handle consulting work and his real estate holdings. He urges any '36er headed his way to look him up in Newport Beach, Calif. . . . **Stanley Stolz** writes from the Virgin Islands, where he is Assistant Director of the Division of Environmental Health, that he enjoys his work, the weather, and sailing. . . . From Lake Charles, La., **Gerry McMahon** reports that his oldest daughter was married last summer, his fifth child started college this fall. The youngest is a junior in high school. . . . Just before Thanksgiving your Secretary travelled to Cleveland for the marriage of her second child and only son, Tom. The bride is a graduate of Case Western Reserve with a major in Chemistry, as is Tom, who received an M.S. in Operations Research in June and is currently employed by the Cleveland Board of Education—**Alice H. Kimball**, Secretary, P.O. Box 31, West Hartland, Conn. 06091

## 37

Hope you enjoyed Les Klashman's notes last issue and that you have sent him many letters as he will be doing the next issue. Your Secretary, at the request of our Class Agent, John Fellouris, joined with John, Dick Young, Ralph Webster and Phil Peters at a M.I.T. telethon. If you get a chance to participate in one of the Institute's telethons, be sure to accept as it gives one a chance to phone your distant classmates and to chat a while. It was good to see Dick Young back in the country once again. He and Marge enjoyed England while he was stationed there by Arthur D. Little.

**Sid Mank** is still in Florida in Fort Lauderdale and after retiring, is still involved in the construction business. Wells Coleman missed our 35th Reunion as he was vacationing in England with his wife Mabel, at that time. He writes that all

three of his boys have flown the coop. Score: 5 Grandchildren and they all live in the nearby Rochester area. **Ed Corea** is working on a special assignment of investigating a claim against the navy at Supships, Quincy, as a result of ships built at General Dynamics Quincy Yard. Dr. **O. William Muckenhirn** recently visited M.I.T. for the first time in 31 years. He saw a tremendous change of course in the campus, but the E.E. office hadn't changed a great deal.—**Robert H. Thorson**, Secretary, 506 Riverside Ave., Medford, Mass. 02155; **Lester H. Klashman**, Assistant Secretary, P.O. Box 961, Peabody, Mass. 01960

## 38

The biggest news concerns our President, **Bob Johnson**, who has been elected President and Chief Executive Officer of Arkwright-Boston Manufacturers Mutual Insurance Co. and Mutual Boiler and Machinery Insurance Co. These companies are a member of the Factory Mutual System and are headquartered in Waltham, Mass., with combined assets of over \$350,000,000.

**Cliff Nelson** writes that he is "still in full-time research at Maine Medical Center. Am editing a book to be titled *The Theoretical Basis of Electrocardiology* to be published by the Clarendon Press."

... **Henry Homeyer**, in a short note, said "my daughter, Mrs. Ruth Anne Mitchell, lives in Cameroon, West Africa, where her husband is a lecturer in Math. My son Henry and his wife, Gretchen, are touring in Europe. My wife Elfrieda is a social worker. My principal client at present is Entoleter Inc., who make air pollution control equipment." ... **Ed Hadley** moved to Boxford, Mass., last fall after "3,000 years in Chatham, N.J." He lives a short distance away from **Jack Bethel**.

By the time you receive these Class Notes you should be receiving a mailing piece on the Class Reunion to be held at Stratton Mountain. Put all excuses aside and mark the dates June 1 to 3 in red letters on your calendar.

This monthly report ends on a sad note. **Milt Wallace** died suddenly at the age of 54 at his home in Virginia. Many of you will remember that Milt was a retired lieutenant colonel in the army and had faithfully attended every Reunion that he could make.—**A. L. Bruneau, Jr.**, Secretary, Hurdman and Cranstoun, Penney and Co., 140 Broadway, New York, N.Y. 10005

## 39

**Kenneth L. Cook** wrote: "During July 20 to October 20, I spent my sabbatical leave from the University of Utah at the Geophysical Department, Colorado School of Mines, Golden, doing research work." ... And from **Allen Monderer**: "Just moved my business operation from Colorado Springs to Denver. Same business but with a new name: Hardware Showcase, Ltd. I sell fancy hardware and plumbing fixtures (yes, 24K gold-plated) to builders and homeowners. It takes imagination and creative ability. I

have hundreds of boxes to sort out and many displays to rebuild in this new location. It's a far cry from communications, but it's an intensely interesting business." ... **Bob Sackheim** noted that he has been Vice President of Longines Symphonette Society for the past seven years, working on various phases of mail order activity. He is looking forward to moving into a brand-new eight-story building in New Rochelle, N.Y., to be ready for occupancy in March, 1973.

**Irving Peskoe**, Attorney at Law, didn't write about himself, but sent an intriguing clipping from the *Miami Herald* about his youngest daughter Anne, now a sophomore at Georgetown University, who served as a hostess during both the Democratic and Republican National Conventions. She is a political science student. ... **William E. Davies** was one of nine commissioners appointed by the Governor of West Virginia to investigate the Buffalo Creek flood disaster. ... Here's a timely and thoughtful expression of thanks from **Sidney Silber** to **Seymour Sheinkopf** for his many hours of volunteer telephone solicitation for the Alumni Fund. Sid wrote that it was a real thrill to get a call from M.I.T. after all these years. ... **Harold R. Seykota**, that famous world traveller, is extending the consulting services he initiated in 1971. As Seykota Associates, he offers management and engineering services for the petrochemical industry in the United States and abroad. ... **Burton D. Rudnick** wrote: "I am now President of the B. Dexter Corp., which specializes in the development and management of commercial and industrial real estate in Massachusetts and Connecticut."

From **Ruth B. Pitt**: "I am spending this year in this sub-tropical paradise on a semi-sabbatical (less work and less money), teaching science at a private school for the purpose of self-renewal and rethinking future career plans. La Jolla is a stunningly beautiful place in which to do this." ... **James B. Lampert** was appointed Vice President and Special Assistant to the President and Chairman of M.I.T., beginning this last fall.

**Bob Casselman's** annual Christmas letter, co-authored of course with Dorothy, tells of his consulting assignments with government and with industry, and of his enjoyment with Dot of their ketch, based on Cape Cod. ... Another regular with year-end letters is of course **Fred Cooke**, who with Eugenia wrote extensively of their current activities and children and grandchildren. Fred is absorbed with Dashaveyor's Automated Personal Rapid Transit, and had a major hand in the construction, assembly, and checkout of the Dashaveyor Demonstration Facility at TRANSPO-72, at Dulles Airport last May.—**Oswald Stewart**, Secretary, 3395 Green Meadow Circle, Bethlehem, Pa. 18017

## 40

The annual Alumni Fund drive has resulted in a number of notes from classmates. From **Bill Kather**: "Our consulting business, now in its fourth year, is showing good growth. Gave another talk on 'marketing and business strategies' to the Commercial Development Association recently (in Chicago). Have seen **Jim Rumsey**, who is now also in consulting. Hope members of the Class will visit Peggy and me when in Chicago." ... **Bill McKinley** notes that he was appointed to the long-range planning committee of the Bowen Hill Community Church. At the time of writing, Bob was attending the Columbia University Marketing Seminar. ... From **Lawrence Jones**: "Like M.I.T., I am conditioned to present myself grandiosely while struggling to accomplish very small things extra well. This makes 'my world' strange indeed. I am planning and conducting experiments which may make aging more gracious for us all and be of value to many retarded children." ... **Henry Singleton**, who is Chairman of the Board of Teledyne Ind., received the award for outstanding achievement presented by the University of Southern California School of Business Administration. Write to Al—**Alvin Gutttag**, Secretary, Cushman, Darby and Cushman, 1801 K Street, N.W., Washington, D.C. 20006

## 42

An announcement from the Institute tells of the retirement of **Deane Lent** as Professor of Mechanical Engineering. We wish Deane good health, happiness and much joy in his new-found leisure. ... In the news, we found a *Boston Globe* article about **Paul Crandall's** contest with the New England Division of the Army Corps of Engineers over the Charles River Basin Dam. Apparently, the engineers have estimated that the Dam will cost \$41.8 million. Paul claims that estimate will rise to \$69 million after all hidden costs are in, and that he can build an alternative facility for only \$12 million! We wish him well and it will be interesting to hear of the outcome. ... **Bill Tallman**, President of the Public Service Co. of New Hampshire, was a prin-

Classes '35, '36, '37, '39, '40, '42

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cial speaker of the annual meeting of the Business and Industry Association of New Hampshire, on November 16.

Dr. **Robert T. Olsen** has been appointed to the Executive Committee of the newly-formed American Chemical Society Division of Professional Relations. Bob will be concentrating his efforts in the areas of by-laws and programs. . . . **Edgar Parker, Jr.**, is currently working on analog to digital converters at the L.F.E. Corp., in Waltham. . . . **Sandy Peek** recently moved back to the M.I.T. neighborhood from New Jersey and is now Director of Engineering for Electronics Corp. of America on Memorial Drive in Cambridge.

Just received news that **Richard Small**, Course II, died in Dallas on October 30. Our sympathy to his wife and family.

In the words of Dean Martin, "lets keep those cards and letters coming."—**L. K. Rosett**, Secretary, 191 Albemarle Rd., White Plains, N.Y. 10605

## 44

Well, the Class of 1944 is back in the *Review* again. It took a trip to San Francisco for me to have time to write the notes. Ordinarily I would present the information in alphabetical order but I want to start with **Bill Sadler** because he set a record: The first one to drop me a lengthy note describing activities of himself and some of our classmates. He pointed out that **Reginald Robba**, himself, and I all attended M.I.T. from Webster, Mass., the same year. The three of us have been in Washington at various times but have never gotten together. Bill states, "**Dick Hatfield**, **John Lednicky** and I met briefly after our 25th Reunion. John's family have been close correspondents since my tour with the Military Advisory Group in Manila in '60-'62, and he is the godfather of my 15-month-old grandson. Now working in the I.L.S. Division of the Naval Ship System Command."

Separately, Dick Hatfield on his alumni fund envelope, noted that, "Finishing a successful first year on new consulting company—Collett, Gatenby, and Hatfield. We are consulting to shipyards, to minority business, to small and medium-sized organizations; providing a range of professional management services." . . . In May 1972, **A. Donald Arsem**, Executive Vice President of the Wurlitzer Co., was elected a Director. Don, who resides in Clarence, N.Y., is a member of several technical societies including I.E.E.E., A.S.A., and the New York Academy of Sciences. He has directed Research and Engineering for Wurlitzer since 1958. . . . **J. H. Barnes** has been named President of Killian Associates, in Wheaton, Ill. Barnes was President of Oury Engineering Co., Marion, Oh., since 1966. Prior to joining Oury, he was Vice President for marketing at Service Master Industries. According to the Wheaton *Leader*, he has been very active in church organizations and has four children: James and Paul are graduates of Wheaton College while Peter and Priscilla are undergraduates at Taylor University. . . . **Roland Benjamin** wrote of his trip to Europe in June 1972. He

traveled with his wife Charlotte and his daughters, Elizabeth and Barbara, by rented Simca through France, Switzerland, Austria, and Germany. They especially enjoyed Paris, Vienna, and Arles. Lucky man.

It is with regret that I learned of the passing of **Ian B. H. Bennett**. He is survived by his wife Barbara, two sons and two daughters, in Irving Texas.

Professor **Robert V. Bruce** dropped a note, "My biography of Alexander Graham Bell, entitled, *Bell*, and subtitled, *The Conquest of Solitude*, will be published in April 1973 by Little, Brown, Boston." . . . According to the Department of Commerce News, September 1972, **R. S. Caswell**, of the National Bureau of Standards' Center for Radiation Research, has developed theoretical calculations of the processes whereby neutrons transfer their energy to tissue. While physicians are beginning to apply neutron therapy to cancer patients, theorists at the N.B.S. are studying the basics. Fast neutrons are of interest as they probably kill oxygen deficient cells in the center of a tumor at lower doses than X-rays. . . .

**Robert J. Fleming** is one of 63 chief executives appointed to the National Industrial Pollution Control Council of the Department of Commerce. The N.I.P.C.C. was created by President Nixon in 1970 to provide advice and voluntary action programs to clean-up industry.

In the spring of 1972 the *Globe* had a headline: "M.I.T.'s **Jack Frailey** had an idea . . . and its time has come." In 1964 Jack reasoned that the so-called "left-over" oarsmen would make good Olympic crews with extra training. Now he is light-weight coach at M.I.T. and the idea has been adopted officially for the eight and four boats for the U.S. . . . **Ray C. Frodey** wrote that he was pleased to run into **John Hull** on a transatlantic flight last winter. On the same trip he met Aaron Brody, '51, on a flight out of Paris. These gadabouts. . . . **Thomas W. Lambe**, Department of Civil Engineering, M.I.T., was one of 11 engineers elected to the National Academy of Engineering in May 1972. His election was based upon his contributions to knowledge of soil structure, settlement control, foundation performance, and earth structures.

A note from **Jean-Claude Landau** reports that he and his family have moved to Belgium: 72 rue Roberts Jones, 1180 Brussels. Ten persons—including a 21-year-old woman, an internationally famous architect, a prominent surgeon, and seven distinguished leaders in business and industry—were elected to the M.I.T. Corporation in June 1972. Among them was **Clint W. Murchison**, of Dallas, a partner of Murchison Bros., and owner and chairman of the board of the Dallas Cowboys. Clint is a member of the Development Committee and has served on the Visiting Committees for Sponsored Research and the Sloan School. . . . **N. R. Nelson** included a status report with his gift. "After spending more than ten years in the Pittsburgh area working on central station nuclear power management for Westinghouse, I am now in the Washington area working for the Environmental Protection Agency as Staff Director of its energy policy committee." . . . Eastman

Kodak announced the appointment of **Roger W. Patterson**, of Penfield, N.Y., as Program Manager of the newly formed vendor product engineering group in the business and professional products organization. Roger joined Kodak in 1946 at the Camera Works, moved to the Navy Ordnance Division in 1948, and in 1954 moved to the Recordak subsidiary, becoming manager of engineering and shops. Most recently he was supervisor of business products, definition, and development.

You probably heard previously that **E. Alfred Picardi** received the 1972 Bronze Beaver Award; He is Past President of three M.I.T. Clubs (Toledo, Chicago, and Washington), Educational Council Chairman, Alumni Fund worker, committee and Board member, and Director of the Alumni Association. . . . **E. P. Radford**, Professor of Environmental Medicine, Johns Hopkins University, contributed a paper at the Westinghouse International School for Environmental Management in the summer of 1972. He had the right idea—it was held at Colorado State in Fort Collins. Radford cited several recent legal battles in which intervenors' arguments reflected several environmental impact concerns. He then presented reasons why the protest movement against nuclear power has developed. . . . **Robert M. Ransier**, formerly Assistant Chief Engineer at Bell Aerospace in New York, has been promoted to Field Manager and transferred to the Arizona Facility to work on the El Centro Project. . . . The Madison Wisconsin *State Journal* for March, 1972, carried a nice article and a picture of **Warren H. Southworth**. Warren is a professor in cross-disciplines at the University of Wisconsin holding appointments in the Schools of Education and Medicine. Previously he helped develop the State School Health Council; he was a consultant to the State Office of Civil Defense, the State Board of Health, and the State Medical Society. Dr. Southworth received the William A. Howe Award in 1968 from the American School Health Association. Send your notes to—**J. G. Barmby**, Secretary, General Accounting Office, Washington, D.C. 20548

## 45

**Robert A. Wiegand** formerly of Chatham, N.J., died suddenly on Saturday, October 21, 1972 at the age of 48. Bob was Manager of International Sales-Petrochemicals for Arco Chemical, a division of Atlantic Richfield. Bob started with a predecessor firm, Sinclair Oil, in early '47 after his stint with the U.S.N.R. Bob is survived by his wife, Dominice; two sons, Richard P., and Bob, Jr., as well as two daughters, Ms. Janet C. and Laurie A. Many of you will remember Bob, a Course X-er, as Company 2 Commander. John T. Reid, '48, thoughtfully forwarded this obituary.

The only other item to report at the moment concerns **William A. Loeb**. Bill is Vice President of Technological Investors Management, a Concern which manages investments and venture capital centered around science and technology. Week-

ends are now kept busy in improving property recently acquired in West Stockbridge, Mass. Hopefully, we will have some Christmas news next month.—**Clin-ton H. Springer**, Secretary P.O. Box 288, New Castle, N.H. 03834

## 47

This typical dreary Cleveland day finds me with the usual pre-Christmas chores and insufficient time due to poor planning. The mail has, however, been very light so for these two reasons these notes will be most brief. **John Breen** writes that he is still employed by Raytheon and has two sons, one, a senior at St. Anselm majoring in history, and the other, a freshman at Merrimack majoring in Civil Engineering. . . . **Bob Blount** is now Commanding Officer of the Naval Station in Charleston, S.C., after finishing a stint as Chief of Staff, Submarine Flotilla Six. His older daughter, Barbara, 18, is attending Duke while Jennifer, 6, is in the first grade. . . . **Harold Raiklen** is with North American Rockwell as Vice President of Research and Engineering at the Los Angeles Division, developing a bomber for the Air Force. Prior assignments had him as Vice President and Program Manager of Saturn II and Vice President of Research and Engineering of the Space Division.

**Carl Jenkins** writes from Rockville, Md., that he is working for the National Oceanic and Atmospheric Administration on the International Field Year for the Great Lakes. Previously he had worked 11 years with the Travelers Research Center. His older daughter, 23, is working in Hartford after graduating from Wells College while the 17-year-old is in high school and an active horsewoman.

As you sit by the fire during these winter months, take a few minutes and drop us a note.—**Dick O'Donnell**, Secretary, 28516 Lincoln Rd., Bay Village, Ohio 44140

## 48

Classmates have begun communicating with one another about the 25th Reunion. Details of plans for program and housing are beginning to take shape. The membership of the Reunion Committee has expanded and now includes: Bob Sandman, Marvin Rosenberg, Bob Bliss, Dave Vigoda, Dick Harris, Herb Lipson, Leon LaFreniere, Mel Berkowitz, Stan Shein, Dave Finnegan, Frank Dugin, Verity Smith, Ted Yoos, Sonny Monosson, and yours truly.

In addition, the following people have accepted as Regional Chairman: Irving Kagan, Maine; Arthur Renz, New Hampshire; Ken Bushway, New Haven; Aldo Fioravanti, Rochester; Mario DiQuillo, Buffalo; Ben Dann, Waverly; Dick Baker, Westchester; John Reid, New Jersey; Ellis Barron, Washington; Dick Snow, Carolinas; Frank Jamerson, Michigan; Tom Zsembik, Cleveland; Bill Moser, Columbus; Frank Jones, Memphis; Chuck Licht, Chicago; Ed Mack, Wisconsin; Louie Rasmussen, Kansas City; Bob Hanpeter, St. Louis; Tom Pawel, San An-

tonio; Paul Erskine, Los Angeles; Dick Baum, Phoenix; Fred Horstkotte, Portland; Bill Sewall, Washington and Al Tom, Hawaii.

The program details are not finalized but Dave Vigoda's sub-committee will be selecting a Country Club or similar large facility for Friday's activities off campus. Golf, tennis, and swimming are expected to be available. On Saturday, a more traditional day on campus is being planned with seminars and faculty participation. Arnold Smith suggested that classmates who are members of the M.I.T. Educational Council have a meeting with representatives from the Admissions Office and the Educational Council. In the evening a banquet and dance is being planned. On Sunday, provision will be made to assist classmates touring the campus. In the evening the Boston Pops will perform for Tech Night at the Pops. On Monday the program is being planned by the Alumni Association's Homecoming Day Committee.

Housing the 600 to 1500 people who are expected (200 to 500 48er's and their families) will require using several M.I.T. housing units. Most classmates will be in McCormick or Burton House, but McGregor and Baker Houses may also have to be used.

**Ezra Garforth, Jr.**, has written that Edna and he think the mid-west is great. Ezra is Executive Vice President of Central Screw Co., of Broadview, Ill., with manufacturing plants in Keene, N.H., Frankfort, Kentucky and Sonoma, Calif. . . . **Raymond R. Edwards**, is Vice President of Technology Associates of Southern California (T.A.S.C.), a closed corporation of M.I.T. alumni that was recently incorporated for Research and Development and consulting in all areas of M.I.T. Course work. They have 33 shareholders and 150 affiliates—all M.I.T. alumni. . . . **William Papian** has changed his job from Professor of Electrical Engineering at Washington University, St. Louis to visiting scientist at Health Services and Mental Health Administration, Rockville, Md.

**Harold L. Abrams**, President of Lumberjack Meats, Inc., was elected a director of Kane-Miller Corp. . . . **Pete Richardson** who had been Associate Director of Admissions of M.I.T. for several years was appointed Director of Admissions at M.I.T. . . . Last week I had lunch with **Dick Baker** in New York. Dick's firm manufactures men's apparel on custom order. Another branch makes a range of uniforms for groups such as ambulance drivers and meter readers. . . . I found **Bob Wofsey's** office on Park Avenue has a fantastic view of the East River. During this brief visit we exchanged experiences about our college age children. Bob's daughter Liza is a senior at Clark University. As a result of our conversation, my son Clifford visited Liza at Clark to determine whether he would like to apply for admission. Bob conducts Management Training courses for Arthur Young Co., in cities in the U.S. and abroad.

After our Reunion Committee meeting **Marvin Rosenberg** described his business which does inventory of parts for trucks that are no longer in production. Marvin makes involved risk calculations based on the number of vehicles that are still in

service and the frequency of repair record in order to determine whether to have additional parts manufactured.

**Mrs. Robert W. Griffin** wrote that her husband, Bob, died of lung cancer on November 19, 1971 after a three-week illness. Bob graduated in Course XV and had been working for Philco-Ford in Ramsdale, Pa. Bob's five children range in age from kindergarten to a married daughter. Bob was a Theta Chi. . . . On November 14 of this year **Harold Kilgore, Jr.** died unexpectedly in South Portland, Maine. Harold had been President of Dustin Associates, Inc., construction engineers. Besides his wife Ruth, he leaves five children. Harold was Scoutmaster of Troop 732 in Reading, Mass., in addition to a number of other civic and professional activities. . . . **John E. Schmidt** of Westmont, N.J., died on February 17, 1972.

On behalf of the Class our sympathy is extended to the families of these men.—**S. Martin Billett**, Secretary, 16 Greenwood Ave., Barrington, R.I. 02806

## 49

We start off this month with a full-fledged letter from **John P. Horton**, as follows: "Every now and then while reading the *Alumni News* and the *Technology Review* I get a feeling that I should write and bring people in the Class up to date.

"I suppose my most interesting news lately is in two forms. One, Jean and I just celebrated our 25th wedding anniversary. **Bruce Campbell**, also Class of '49, came down for the weekend to help us celebrate it. We followed it up with a tour through Europe, visiting mainly the Balkan countries of Greece, Turkey, Bulgaria, and Roumania.

"I got back to check on my newest venture which happens to be a restaurant. For many years I have wanted to get into the restaurant business and I finally did in July. We took over a country restaurant in New Jersey and renamed it 'The Great Raritan and Passaic Dry Goods and Sundries Restaurant'—of all things. With a couple of imaginative recent graduates from Cornell Hotel School, we have managed to do about three times the business we thought we would. Fascinating. I'm not sure how four years in Cambridge helped

Classes of '44, '45, '46, '47, '49

## MINI-REUNION SUNDAY, JUNE 3RD

Directly preceding  
International Buffet,  
Boston Pops.

## ALUMNI DAY JUNE 3RD & 4TH

Send in coupon at end  
of class notes **NOW!**

this, but it's a lot of fun anyway.

"I seem to specialize in small operations. I now have investments in four small private companies in Europe, in addition to the restaurant. Makes life fascinating, sometimes confusing." Thanks, John, from all of us.

Three notes received this month from the Alumni Fund: Rear Admiral **Harvey E. Lyon** is now Project Manager, Trident Submarine System. . . . **Arthur D. Halenbeck** reports, "have received a one-year grant from Aerospace to return to school. Am now at U.C.L.A. in the new Academic Masters Program studying Operations Research." . . . **Fred W. Reusswig** writes, "Recently saw Hunter Rouse who has been globetrotting as a Roy Carver Professor at the University of Iowa after completing his assignment as Dean of their College of Engineering. Heard from Maury Lynch who has joined the ranks of consultants in California. In June I was elected to Stanley Consultants' Board of Directors. My job as head of S.C.'s Operations Division continues to offer challenge and variety in the planning, design and construction-related services of the firm. Would enjoy hearing from (and better yet, seeing) M.I.T. grads who visit Iowa."

**Robert C. Cowen**, whose career we have followed through London and Washington, now makes his home in Concord, Mass., and is Features Editor of the *Christian Science Monitor*. . . . Finally, two reports, strangely timed to arrive together: first, the National Sanitary Foundation reports that **Robert J. Collins** has joined the staff as Assistant to the Executive Director, and will focus on applications of plastic materials and plastic pipe. He was previously Market Development Manager of the B.F. Goodrich Chemical Co., where he guided the manufacture, development and sales of P.V.C. pipe. Second, we have word that **George Piness, Jr.**, has been appointed Vice President of Bobrick International Division of Bobrick Washroom Equipment, Inc., Los Angeles. George assumes this job after a number of years with Wayne Manufacturing, Pomona, Calif., a leading U.S. heavy-equipment manufacturing firm. It looks like our classmates are starting to clean up the world. Best wishes to all.—**Frank T. Hulswit**, Secretary, 77 Temple Rd., Concord, Mass., 01742

## 50

**Sterling G. Brisbin** was recently named President of Stearns and Wheler, Civil and Sanitary Engineers, Inc., of New Canaan, Conn.—an extension of the same firm doing business in New York State as a partnership. The firm specializes in environmental engineering. . . . **Carl F. Long** was appointed Dean, Thayer School of Engineering, an associated school of Dartmouth College, on October 6.

We are sorry to announce the death of **Aaron Glickstein** on September 17, 1972. He is survived by his wife, Constance (née Weill); his daughter, Karen; and son, Kenneth.

After leaving M.I.T. faculty "temporarily"

for military duty, **Donald R. Walker** now finds himself with over 16 years at Avco Corp. He is currently Vice President at Systems Division, Wilmington, Mass. Donald is also now completing the twelfth (and final) year as Chairman, Reading School Committee. . . . **Irvine F. Williamson** has been promoted to Plant Manager, vitrified products, of Norton Company's Grinding Wheel Division. Irvine joined the company in 1954 as an industrial engineer and held several supervisory positions before being named Superintendent and later Manager of the company's Santa Clara, Calif., plant in 1960. He was named Superintendent of the small vitrified products plant in 1965.

**Edward L. Friedman**, Associate Professor of Electrical Engineering at the University of Hartford, has been appointed Assistant to the President, University of Hartford. Mr. Friedman joined the university faculty in 1962. He holds two advanced degrees, the master of arts, '51, from Yale University, and master of science, '62, from Rensselaer Polytechnic Institute. He is a registered professional engineer in Connecticut and Vermont, and has just received his private pilot's license from the Federal Aviation Administration. Professor Friedman is married to the former Esia Baran. They have two sons, Charles, 19, and Cary, 8. Charles is a University of Hartford sophomore in electrical engineering, and Cary is in the third grade.

**Raymond N. Blair** is the co-author of a book entitled, *Elements of Industrial Systems Engineering*. This book presents a broad, balanced, and inclusive picture of the engineering approach to human activity systems. In the past, industrial engineering has tended to be presented piecemeal as a collection of various time study, plant layout, methods analysis, human engineering linear programming, and engineering economy techniques. This book shows the place of each in a general methodology of human systems design, developed from simple, fundamental concepts. Mr. Blair is a member of several professional organizations and has published about 75 feature magazine articles. . . . **Frank H. Tyaack** has been appointed to the new position of General Manager of the process equipment and systems divisions of Westinghouse Electric Corp. He will have responsibility for the industrial systems division in Buffalo, N. Y.; the computer and instrument division headquartered in Pittsburgh; and the industrial equipment division in Sykesville, Md. Mr. Tyaack joined Westinghouse in 1953 as an electronics engineer with the defense and space center. He is married, has two children and lives in Monroeville, Pa.

**Gerald A. Lessells** of Edison, N.J., has been elected a Director of the American Institute of Chemical Engineers for three years beginning 1973. This was announced at the 65th Annual Meeting of American Institute of Chemical Engineers in November. Mr. Lessells is currently Technical Director, Ink Division, J. M. Huber Corp., as well as a member of M.I.T.'s Educational Council; Vice Chairman of the Research Committee of the National Printing Ink Research Institute, Lehigh University; life member of

N.A.A.C.P.; and a member of the American Chemical Society. He holds six U.S. patents; has had 15 articles published in technical and trade journals; and is a licensed professional engineer in Ohio and Illinois. He is married to the former Joline Reddan of Arlington, Mass. and has three sons.—**John T. McKenna, Jr.**, Secretary, 2 Francis Kelley Rd., Bedford, Mass. 01730

## 52

The U.S. Army Computer Systems Command, Fort Belvoir, Va., has announced that Lieutenant Colonel **Daniel L. Lycan** has been presented the Legion of Merit by Major General Henry C. Shrader, Commanding General, U.S. Army Computer Systems Command. Colonel Lycan is presently commanding a support group of the Computer Systems Command at Presidio in San Francisco, Calif. He received the reward for exceptionally meritorious conduct during the period August 1971 to July 1972 while serving as Commanding Officer, 84th Engineer Battalion and as Chief, Engineer Operations Advisory Branch, Engineer Advisory Division, Office of the Director of Logistics, United States Military Assistance Command, Vietnam. . . . **Clyde N. Baker, Jr.**, of Northbrook, Ill., was a co-recipient of the Thomas A. Middlebrooks Award for his efforts in co-authoring the paper "Caisson Construction Problems and Correction in Chicago." The award was given by the American Society of Civil Engineers at the Annual and National Environmental Engineering Meeting, held at the Rice Hotel in Houston, Tx., October 18. Mr. Baker is chief engineer of Soil Testing Services, Inc. of Northbrook, Ill. . . . **Stanley E. Charm** was co-author of a paper discussing a method for removing hepatitis antigen from blood plasma at the 164th National Meeting of the American Chemical Society in New York on August 30. Dr. Charm, who is Associate Professor of Biomedical Engineering and Director of the New England Enzyme Center of Tufts University School of Medicine, described a process that will make it possible to prepare, for the first time, on a large scale, hepatitis (antigen)-free plasma. . . .

A note has arrived from **Donald Jaffe** saying that his daughter Nancy is a sophomore at Wellesley and is taking two courses at M.I.T. Donald is supervisor on the technical staff at Bell Labs. . . . **William P. Chandler** writes that he was promoted during 1972 to Manager for Administration, the Marketing Department, B.P. Oil Corp., a subsidiary of Standard Oil of Ohio. Bill says that his 18-year-old daughter enrolled in the Class of 1976 at Skidmore College this fall. His wife, Isabel, is handling larger P.T.A. responsibilities at Riverwood High School in suburban Atlanta where his 14-year-old son is a sophomore. . . . **Dana W. Mayo** is now Charles Weston Pickard Professor of Chemistry as well as Chairman of the Chemistry Department at Bowden College. He is working on oil pollution problems with particular emphasis on the Maine Coast. . . . A note from **Edwin H. Porter, Jr.**, indicates that he returned to

the Draper Laboratories last November after two years as Associate Director of M.I.T.'s Urban Systems Laboratory. He is currently Director of the Educational Activities Division at the Draper Labs. . . . A card has arrived from **Douglas F. G. Haven** announcing a new affiliation with Trend Financial, Inc. Cambridge, Mass. . . . **Baird-Atomic, Inc.**, has appointed **Arthur S. Turner** of Carlisle, Mass., General Manager of the Spectrochemical Division. . . . **James M. Margolis** presented a paper entitled "Investment Returns in the Chemical Industry in the 1970's" at the 1972 Annual Fall National Meeting of the American Chemical Society in New York. Mr. Margolis is President of Margolis Marketing and Research Corp., White Plains, N.Y. . . . Two letters have arrived from our Assistant Secretary, **Dick Lacey**. Dick writes that **Don Grine** left Stanford Research Institute a year ago and moved to La Jolla to work for a company called Systems Science and Software, Inc. Dick says that he ran into **Art Freeman** at the Annual Conference on Magnetism and Magnetic Materials in Denver after Thanksgiving. Art was involved in the presentation of five papers at the conference. Upon being asked why the large number of papers bearing his name at the conference, Art said that it was just to show he was back in physics. Art is a member of the Department of Physics at Northwestern University and also works at the Argonne National Laboratory. . . . According to Dick, **Bill Hawe** created his own sales firm—Hawe Technical Enterprises, handling several lines of vacuum equipment and supplies. He has turned gray, as many of us have, and now wears a Horace Greeley beard as many of us do not. Dick says this gives him that up-to-date 19th century look.—**Richard F. Lacey**, Assistant Secretary, 2340 Cowper St., Palo Alto, Calif. 94301; **Arthur S. Turner**, Secretary, 175 Lowell St., Carlisle, Mass. 01741

## 53

We are delighted to report that the forthcoming reunion in Bermuda for next year has received great initial response from the Class. Our questionnaire results indicate that approximately 65 class members plus wives and family totalling about 150 are now planning to attend the May 30 through June 3 get-together at Castle Harbour Club in Bermuda. **George Hegeman** is planning a lively affair for the Class, and he is planning certain surprise events which will be announced later.

In recent months, members of our Class have made significant accomplishments. **John Schrieffer** was a co-sharer of the 1972 Nobel Prize for Physics. The remarkable aspect of Schrieffer's Nobel award was that in 1957 he was the youngest of several physicists who shared in the discovery of solving the origin and cause of superconductivity. Although the concept of superconductivity was discovered as early as 1911, it was not until 1957 that Schrieffer and his associates determined the underlying causes or its effect. . . . Also, we wish to acknowledge that one of our classmates

has become a well-known author. He is **Eugene Mirabelli** who attended M.I.T. and then Harvard. Gene now teaches writing and American literature at the State University of New York in Albany. His latest novel is *No Resting Place*. . . . **Chuck Homsy** continues with his frontier work in the application of Teflon as an in-plant material for surgical applications. Chuck as been leading this work in the Houston area through affiliations both with Baylor Medical School and Rice University.

**Dick Simmons** has recently been elected President of Allegheny Ludlum Steel Corp. Dick formerly served as Executive Vice President and Chief Operating Officer of the steel company. . . . **Marty Wohl** has decided to return to academia by accepting the position of Professor of Transportation System Planning at Carnegie-Mellon University in Pittsburgh. . . . **Charles Brown** indicates that he recently married Carolyn Moore and now lives in North Palm Beach. He is construction manager for Kassuba, a large residential builder. **George Fuld** reports that he and his wife are running their own business—a mail order stamp and coin enterprise. As I recall, George was already a stamp and coin collector when he first entered M.I.T. I am sure that his love for this field over a long period will ensure his and his wife's success. . . . **G. W. Balz** indicates that he is living life to the fullest. After 14 years as President of his firm, he became Board Chairman and now devotes most of his time to Research and Development and foreign business activities. He is still flying and in September of 1972, won the National Air Races event at Reno, Nev., in the unlimited division. He plans to join us in Bermuda.

**Jim Ricketts** indicates he is doing vehicle diagnostic studies for the engineering staff of General Motors. The Delta III diagnostic vehicle recently announced by President Cole of GM was under Jim's responsibility. . . . **Dave Rollins** indicates he has left the engineering field and is now very much enjoying his new activity of teaching eighth-grade science in Henderson, Nev. (David, I think there are a lot of your classmates who would like to do the same. Good Luck!) . . . **Mike Gruenbaum** is now Special Assistant to the Commissioner of the Massachusetts Department of Public Works. Mike has become actively involved in community planning and land use in the state.—**M. C. Manderson**, Secretary, Longley Rd., Groton, Mass. 01450

## 54

OK, it's 1973 and you are a little nostalgic as you enter a new year of promise and yet look back on past accomplishment. Now would be a great time to make your donation to the Alumni Fund and drop a note on your activities, business and otherwise. At least drop the note, and if you know of news about our classmates, please include it.

**Phil Sayre** is at M.I.T. as a Sloan Fellow. Phil's last known address was Guilford, Conn., and this must be somewhat of a homecoming for this former Norwood resident. While pursuing his "load of

bricks" schedule at the Sloan School, Phil commutes to the Cape where his family has been staying. . . . **Andy Kariotis** continues to move ahead. Alpha Industries, Inc., of Woburn created the position of Executive Vice President for Andy. Not bad for a four-term Dean's list graduate of Course XV. He will have the semiconductor, solid state, and services divisions reporting to him. He lives with his wife and two children in Wayland. There are at least six other classmates in that little town including **Herbert Brun** who at last report, was doing well as a Technical Director for the Raytheon Co. I believe that Dr. **John Blair** also works for Raytheon and that **Henry Brockelman** is helping to manage the family store in Westwood.

Our classmates on the move include **Ari Miliotes** who has moved into a new house in Arlington, Va. Ari is still Manager of the Washington office of The Mathematical Applications Group, Inc. (a software firm). . . . **Dick Walker** transferred to Buffalo, the home office of National Gypsum as a Director of Manufacturing. This responsibility covers ten manufacturing plants with their related mines or quarries. They extend from Nova Scotia to California with most of the facilities West of the Mississippi. Dick indicates that he and Carol and their four boys have climatized (Brrr) and now enjoy skiing again. Dave and Chuck, both having lived in Syracuse, were always thankful that there was one place (Buffalo) that was colder and had more snow than Syracuse. Good luck Dick. If you come across **Frank Ryan** (69 Delaware Ave.), let us know what he is doing besides shovelling snow. . . . **John Pierce** after the abolition of his laboratory at A.F.C.R.L., joined Signatron, Inc. of Lexington, Mass. This gives John the chance to view government from the other side of the fence. Other relocations include: **Bill Zoino** and **Don Goldberg** now in their new offices in Newton Upper Falls; **Paul Stern** to Coldwell, Bunker, and Co. where he specializes in the sale of industrial and investment securities; **Dick Hayes** to join Xerox Corp., as Vice President of the Business Products Group; **Bob Anslow** to President of Roanwell, just three weeks after becoming Executive Vice President; **George Sebestyen** to group Vice President of Sanders Associates Federal Systems Group; and **Henry**

Classes of '50, '52, '54

## MINI-REUNION

SUNDAY, JUNE 3RD

Directly preceding  
International Buffet,  
Boston Pops.

ALUMNI DAY  
JUNE 3RD & 4TH

Send in coupon at end  
of class notes NOW!

**Briggs** to Vice President, engineering for Cummins-Chicago Corp.

Now let's back up the tape a bit and add a few tidbits. Goldberg-Zoino and Associates are soil and foundation engineers. Sounds like these two Course I graduates have their feet firmly planted on the ground. In addition to a growing business, they continue to grow as they are presently taking special courses part-time in graduate school. . . . Paul Stern is continuing to grow too. He and Marilyn are expecting their third child in March to join Deborah and Adam. . . . **Dick Hayes** left N.A.S.A. where he was Director of Systems Engineering when he joined Xerox. He is the author of more than 50 scientific papers and has been honored by the U.S. Jaycees with their Distinguished Service Award. Dick and his family live in Pittsford N.Y., a suburb of Rochester. Perhaps the Hayes' and the Urlaub's could get together and reminisce about the good ole' days at Tech.

In the academic world; **Bill Thompson** received his Ph.D. in Engineering Acoustics from Penn. State. . . . **Valfrid Palmer** graduated from the Advanced Management Program of the Harvard Graduate School of Business Administration. . . . **Fred Holmes** is teaching History of Science at Yale. . . . **Stewart Smith** is Chairman of the graduate program in geophysics at the University of Washington, after nine years on the faculty at Cal Tech.

We are saddened to learn of the death of **Phil Perry** in October, 1971. Phil was an engineer with Pratt and Whitney. He was a native of Gardner, Mass. and has lived most of his life in Peterborough, N.H., before moving to Glastonbury, Conn.

**Peter Rigopoulos** is a Director of Amicon Corp. Pete has been Vice President and General Manager of Amicon's Scientific System Division since 1965 and is also chairman and director of Amicon N.V. in the Netherlands and Amicon Ltd. in England. . . . Speaking of overseas, no one could come up with the country that **Bob Evans** now resides in. The personable redhead is sharing rice with the Japanese. Ok now, in what country is **Frank Ahearn**? The first winner wins a slightly used Hoodsie stick. . . . Our unknown classmate this wintery month is that gentleman that used to hail from warm Texas. Does anyone know where popular **Mike Boylan** is these days? . . . Happy Valentine's day and all that sort of thing. Send us a card, valentines or otherwise, a note, or call.—**David Howes**, Acting Secretary, Box 68, Carlisle, Mass. 10741; **Chuck Masison**, Assistant Secretary, 76 Spellman Rd., Westwood, Mass. 02090

## 56

Dr. **Bob Barenberg** specializes in kidney dialysis and kidney disease in Albuquerque. . . . **Phil Bromberg** is an Associate Professor in Chemistry at Carnegie Mellon Institute. . . . **Don Brusch** has a new company, General Business Services. It acts as consultant to small businesses in Chester County, Pa. . . . **John Hofmann** is in the management division of Exxon

In New York. He works as an analyst in the gas department. In the summer, he and the family are at their cottage in Wellfleet on the Cape. . . . **Dick Jacobs** of Northbrook, Ill., is a principal at A. T. Kearney, International Consultants with headquarters in Chicago. . . . In the business world, **Jim Mulholland** has been made a partner of the firm, Paulus Sakolowski, consulting engineers to the construction industry in the New Jersey area. Dr. **Ira Polevoy** is a surgeon in Denver.

Dr. **Judi Gorenstein Ronat**, psychiatrist, is working in research at the medical school in San Francisco on a National Institute of Health Fellowship. Husband, Ed, is on a sabbatical at Stanford. They return to Israel September 1, and she will resume clinical work while he will be at the Technion. Their children are 10, 8, and 2. When Judi is at work, the baby is cared for by the university nursery. The older children must be coached in both English and Hebrew in all their school subjects. It is a busy and demanding schedule, but they would be happy to hear from their friends. Until August 1, the Ronats are at 1354 Grizzley Peak Blvd., Berkeley. . . . Dr. **Rosemarie Wahl Synek** has moved from Texas Christian to the University of Texas at Austin. She is a Visiting Assistant Professor in the Department of Zoology and Microbiology, teaching genetics and virology. At the time of our Class Reunion, Romie was presenting a paper on D.N.A. replication at the annual meeting of the American Society of Biological Chemists. Her husband is a Regional Science Advisor in the Physics Department of the University of Texas, and their daughter, Mary Rose, is in first grade. . . . **Merlin Lickhalter** has been appointed to the National Board of Alumni Clubs. . . . Dr. **Howie Trachtenberg** of Longmeadow, Mass., is in private practice in a ten-man group. . . . **Don Weiner** is an Associate Professor in Electrical Engineering at Syracuse University.—Cosecretaries: **Bruce B. Bredehoff**, 3 Knollwood Dr., Dover, Mass. 02030; **Mrs. Lloyd Gilson**, 35 Partridge Rd., Lexington, Mass. 02173

## 57

This month I have three letters to report that came in response to a series of requests for news that I sent out. The first is from **Renata Cathou**, and says: "Briefly, here is what Pierre and I are doing these days: **Pierre**: President of Clinical Assays, Inc., a company which he started about two years ago, which specializes in advanced techniques in the clinical measurements field. If you have high blood pressure, send a sample of your blood to Pierre! . . . **Renata**: I have been on the faculty of the Biochemical Department at Tufts Medical School for several years and also am doing my research of physical-chemical studies of antibody structure, conformation, and function. I teach several graduate courses and some basic biochemistry and immunology to medical students. I just returned from a month's lecture tour of Europe (a fringe-benefit!). Both of us are very content living on Memorial Drive

in Cambridge."

The second letter is from **Alan Budreau**, "No recent change in status or address. I am still working at the Air Force Cambridge Research Laboratories with classmate **Paul Carr**, doing microwave acoustics research. In addition I have become the Boston area's busiest scuba diving instructor, teaching a couple of courses in Cambridge plus three others in the Greater Boston area. I was unable to attend the 15th Reunion because that weekend coincided with the final session of the annual scuba instructors certification course, and I was on the staff, as both team leader and consultant in diving physics. We had a couple of pleasant dives in Rockport and Gloucester. Somehow, I have managed to remain a bachelor, although enjoying a busy social life." . . . From **Art Bergles**, a brief note which reported that he and Penny and their two boys, ages 8 and 4, are well settled in Ames, Iowa. Right now they are beginning to pile up wood for the long winter ahead. Enclosed was a copy of the press release which covers Art's recent move quite well.

"Arthur E. Bergles, Professor of Mechanical Engineering at the Georgia Institute of Technology, has been named Chairman of the Department of Mechanical Engineering at Iowa State University. The five-year appointment, approved by the State Board of Regents meeting at Cedar Falls July 13-14, is effective August 16. Professor of mechanical engineering at Georgia Institute since 1970, Bergles received his S.B., S.M., '58 and Ph.D., '62, from M.I.T. A Fulbright Fellow at the Technische Hochschule in Munich, Germany (1958-1959), he returned to M.I.T. where he served on the mechanical engineering faculty from 1963 to 1969. He was Associate Director of the Heat Transfer Laboratory and Chairman of the Engineering Projects Laboratory while there. A registered professional engineer in Massachusetts, he is a member of the American Society of Mechanical Engineers, the American Association for the Advancement of Science, the American Society for Engineering Education, and the American Institute of Chemical Engineers. He is a member of Pi Tau Sigma, Tau Beta Pi, and Sigma Xi honor societies."

That is all for this month, now I must get back out to the beach.—**Frederick L. Morefield**, Secretary, c/o Mobil Oil Caribe, Inc., P.O. Box X, Caparra Heights Station, Puerto Rico 00922

## 58

Hope your holiday season was enjoyable. Welcome to the New Year and to the year of the Reunion. Here is a New Year's greeting from **Lou Giordano**, publicity chairman for the 15th Reunion: "February is the month of Groundhog Day—sometimes there is sun and then again not. But there is *always* sun on Martha's Vineyard. Hot, hot, sun and surf and sand. At least in June there is, and June 1-3 is our 15th Reunion. If the weather has you daydreaming of those carefree summer days, how about planning ahead now for that weekend away from it all?"

So, dig out that last announcement we sent you, send in your class dues, and the reply card saying you'll be happy to share in the fun. Your reunion committee has a summer spectacular lined up including 'Everything You Always Wanted To Do But Were Afraid To Try,' such as sailing, surfing, bicycling or even relaxing. So, if you haven't decided yet, mention it to your woman or man, and don't forget to say that there will be a lot of friendly people attending."

If your Christmas toys—er, the children's toys are broken by now, you should have subscribed to *Toy Review*, a new publication founded and edited by **Lewis Clapp**. The magazine has had great acceptance and he has already moved into larger offices here in Cambridge. It is written by both parents and children and offers critiques as well as recommendations on unusual toys that are not available elsewhere. (Incidentally, I've read the mag and it is really helpful—someone sank my boats and I needed to find sturdy replacements.)

**Huber Warner** has just returned to his position as Associate Professor of Biochemistry at the University of Minnesota, after spending a year on sabbatical at the Karolinska Institute in Stockholm, Sweden. . . . **Robert Schmidt** is presently a research associate at the University of Washington and working on shock physics and impact technology. He reports that it was a busy '72 with the arrival of a daughter, Erica Robin, in March and the receipt of his Ph.D. in Aeronautics from U.W. in August. . . . **Harvey Rosenfield** is "continuing to do personnel placement in the data processing community but right now most of my business is in computer systems design, programming and consulting." . . . Author **Stan Klein** had a feature article in the August, 1972 issue of *Science Digest*. The topic was the engineering concepts program for high school students, based at the Polytechnic Institute of Brooklyn. . . . Another author, **Mel Copen**, has written a new book entitled *International Management and Economic Development*. . . . Eastern Airlines has announced that **Roden Brandt** has been promoted to the position of division Vice President—reservations and telephone sales. Previously, he was System Director—airline planning. Roden and his wife have moved from New York to Miami Lakes. . . . Another eventful year for **Bill Duffy** who reports "receiving both a third son, Bobby, and a second master's degree. Am now in my fourth year as a high school chemistry teacher and couldn't be happier."—**Michael E. Brose**, Secretary, 30 Dartmouth St., Boston, Mass. 02116

# 59

Let's start out by finishing **Adul Pinsu-vana's** letter which we began last month ". . . I have kept in pretty close contact with some fellows like Jerry Whiteman, and saw Dick Solomons in Bangkok once several years ago. **Narinder S. Saluja** is now a Bangkok resident so I see a lot of him. I would appreciate hearing from some other people like: **Bob Muh** with whom I played soccer; and **Irving Van**

**Horn** who always was a problem for me in East Campus when I was House Chairman; and some of the group on InsComm, DormComm, Secretariat, Beaver Key, and all.

"We have an M.I.T. Club of Thailand in Bangkok with about 70 active members. I have been married since 1962 and have three kids—a girl, 9, and boys, 8 and 5. So much for my story. Working for the airline, I have a pretty good chance to travel, especially to the West Coast. I would appreciate hearing from any tech tool that remembers me from Course XVI and East Campus. I have our group picture that was taken in June '59 near Kresge Auditorium and if anyone writes, I will print some and send them to him." Adul can be reached at 37 Soipichaimontri, Phaholyothin Rd., Bangkok 9, Thailand.

**Joe Burgiel** recently co-authored a paper, "R.E.G. Circuits Extend Central Office Service Areas" in the September '72 *Bell Laboratories Record*. Joe is supervisor of the Loop Electronics Group in the Loop Transmission Electronics Department at Bell Labs, Whippany, N.J., where he has worked since 1963. He is presently a member of the American Physical Society, Tau Beta Pi, Eta Kappa Nu, and Sigma Xi and enjoys climbing, mountaineering and nature photography. . . . **George Peckingham** has been promoted to Superintendent of the tube mill at the Bridgeport Brass Co., a division of National Distillers and Chemical Corp. George joined the company as a process engineer upon his graduation from the Institute in 1959. . . . We have a note from **Carl Poedtker** who wrote, "I have been associated with Price Waterhouse since early 1966 as a member of the staff of our Chicago Office. I was admitted to partnership July 1, 1972 and have been transferred to our New York office in the Wall Street area. I am engaged in providing management advisory services for our clients. I have become associated with the M.I.T. Alumni Center here in New York City. I now reside at 38 West Branch Rd., Weston, Conn., with my wife Marie-Paula, our daughter Gigi, 8, and our son Carl the 3rd, 3."

**Jerry Schooler** "joined the City of London Polytechnic as Senior Lecturer in Management as the Course Tutor for the Diploma in Management Studies. The course is integrated with all fields of management. It is a big package, but dynamic, experimental, job-task-centered and customer-oriented!

"What is more interesting about my new position is that there is roughly four months holiday per year. Consulting is encouraged and the salary is comparable with industry (which is damn low compared with U.S. standards!) Perhaps I may have the opportunity to attend next year's Alumni Day and see all the happy '59ers."

**Phil Richardson** wrote me a newsy letter after Chuck Staples and I missed reaching him during the 1959 Alumni Fund Telethon. Phil reports, "This last summer, Charlotte, myself and the two boys, Jeremy, 5 and Keith, (8 and hopefully the Class of '85) spent a month in Pocasset on the Cape, between Buzzards Bay and Falmouth. I spent a couple of weeks com-

muting between New York City and there, via the bus into Boston and then the plane into N.Y.C. We stopped in on Dotty and **Lloyd Howells** on our way back to New York. Lloyd has a new job in downtown Boston and a new addition to his family. We got into a long discussion about where to hold the 15th Reunion. I think he and I both prefer the Cape. We're planning to spend next August ourselves back in Pocasset. Maybe you can make it down one day and we can have a mini-reunion.

"Both boys are now in Walden School, in Manhattan. Charlotte, by the way, should finish her master's in social work at Hunter this coming June. Then she hopes to spend a month in Mexico at C.I.D.O.C. brushing up her Spanish. I'm still managing the municipal note department for Lehman Brothers and doing a considerable amount of travelling to sell the product." . . . **Karl Landstrom** informs me that he has recently transferred to the position of Research Physicist in the Ecology and Environmental Systems Division at Battelle Memorial Institute, Columbus, Oh.

Here are some tidbits gathered at the recent Alumni Fund telethon. **Bob Polvani** is working on a Doctorate in Metallurgy at the University of Conn. . . . **Bill Putt** is President of Holograph Inc., in Connecticut which is in the midst of a public offering. . . . Barbara and **Gerry Stevenson** are now in Los Alamos, N.M., where Gerry is working at the labs on sabbatical from the University of Maryland. They have a 2½ year old boy and a dog in obedience school.(!) . . . **Elaine (Beane) Rocchio** is teaching at Wayne State University in Detroit and is finishing up her Doctorate in Anthropology at the University of Pittsburgh. . . . **Ed Safran** is Manager of Banking and Investment at Polaroid. He has two children, a boy 4 and a girl 3.

**Bob Schlegel** is doing nuclear consulting with Southern Nuclear Engineering in Washington, D.C. . . . **Ernie Potter** has his own company in Americus, Ga., distributing housing supply products to the mobile home industry throughout the South. . . . **Scott Latimer** has been recently promoted to the corporate office of A.S.A.R.C.O. in Manhattan. . . . **Tom Margulis** is on the faculty of the University of Massachusetts at the Boston Campus. . . . **Ken Taber** is working as a welding engi-

Classes '56, '57, '59

## MINI-REUNION

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neer in the Gas Turbine Department at General Electric in Schenectady, N.Y. . . . **Bud Haselton** and **Hank Oberson** have survived the recent aerospace purges and are both alive and well, working for Boeing in Seattle, Wash. . . . **Jack Pogarian** has recently started work for a small outfit in Concord called Metritape Inc. They are in the level-gauging sensor business which sounds intriguing.

One final and sad note this month. It is with deep regret that I relay to you the news of the death of one of our classmates, **Bob Keene**, on October 5, 1972. Bob, a fellow metallurgist, had been with U.S. Steel in Chicago. On behalf of the entire Class, may I extend our deepest sympathy to his widow, Donna, his children, family and friends.—**Arthur J. Collias**, Secretary, 61 Highland Rd., Brookline, Mass. 02146

## 61

As I am writing this I can look around and see the last of the Apollo astronauts pounding away at rocks on the moon. In front of me is an article from *Tech Talk* which mentions that **Bill Lenoir** is a backup crew member of the sky-lab missions next year. Bill is on leave from M.I.T. . . . More down to earth is the report from the air force that **Dwight Kennard** was involved in three rescue missions in one day. Nope—not in Viet Nam, but out in the Pacific near Hawaii. They were finding a missing sloop, dropping pumps down to a sinking sailing vessel and as they were returning home they looked around for the crew of an abandoned ship. A.F.R.O.T.C.-man makes good! . . . Leaving the army is Captain **Roger Whitman**. He is getting out in April and writes to ask "Can anyone use a Course XIX grad with 11 years of army experience?" He also writes that he had a son last July 12, named Randall Todd Whitman. Congratulations.

**Paul Schweitzer** just finished a "very satisfying" year at the Technion in Haifa Israel as an associate professor. Now he is back and hard at work for I.B.M. . . . Meanwhile back in Israel, **Avram Kalisky** is the Chief Scientific Aide to the Director of the National Physical Laboratory in Jerusalem. . . . **Dewey Ryu** is going abroad too. He will be at the Korea Advanced Institute of Science in Seoul next year. Just now he is Visiting Professor of Chemical and Biochemical Engineering at M.I.T. . . . **Joe Harrington** is also still associated with the Institute though more tenuously. He is on the Visiting Committee for Course XXIII. Meanwhile he is back in the "nuclear end" of the power generating business (at Illinois Edison, if memory serves me correctly.)

**Ray Johnson** writes, "Things are really jumping here. Within two months we have moved into a new house, I have transferred to a new job (evaluating computer hardware and software capacity) and Elaine switched from working evenings to days when Greg and Jeff went back to school." . . . **Robert Weimer** who says "On a vacation trip to England last May I was surprised to meet my former Course X classmate, **David Sabo** at the next table in a London res-

taurant. He is working for Imperial Chemical Industries." . . . Finally **Charles Arcand, Jr.**, writes that the American Chemical Society's Division of Professional Affairs approved his organization of a seminar on "Technical Entrepreneurship and Venture Management" for the meeting in Chicago next fall. He also says that he published in the textile research journal last June. It was an article about "The Bottom Ignition Oxygen Index Test." Wazat?—**Andrew Braun**, Secretary, 464 Heath St., Chestnut Hill, Mass. 02167

## 62

Lieutenant Colonel **Leonard B. Stolba** assumed command September 17, 1972 of Marine Reserve Light Helicopter Squadron 771. He has served with the Reserve Helicopter Squadron at South Weymouth in a variety of assignments, ranging from squadron pilot to operations officer. . . . **James L. Walker**, a Lieutenant Commander in the Coast Guard, also received a recent assignment as Project Officer in the Environmental and Transportation Technology Division of the Office of Research and Development at U.S.C.G. with Headquarters in Washington, D.C. His specific project area is Vessel Traffic Systems. . . . Summer of 1973 will find **W. H. Anderson**, who is presently Chief of Neuropsychiatry at the U.S. Naval Hospital, Quantanamo Bay, Cuba, returning to Cambridge, Mass. . . . On October 1, 1972, **Barry Roach**, his wife Kate, and their two Belgian sheepdogs began enjoying a new experience and new home in Lomia Altas, Mexico, after Mr. Roach was transferred to McKinsey's Mexico City Office. . . . **Jerry L. Adams** has been named University Professor at Ohio University for excellence in undergraduate teaching. He also has co-authored a book, *Introduction to Physical Science* which was published by D. C. Heath in 1971 and has sold over 15,000 copies. This past year was an exciting one for Mr. Adams—not only was he Athens City Tennis Champ, doubles and singles, but he was also the Athens County McGovern Coordinator during the recent elections.

On September 1, 1972, **Henry N. McCarl** was promoted to Associate Professor of Economics and is currently completing a study for the United Nations on "Non-Metallic Minerals: A Review of Development Potential in the Emerging Nations." . . . M.I.T. announced the appointment of **Dean E. Eastman** as Visiting Professor in the Department of Electrical Engineering for one year beginning July 1, 1972. . . . **Don D. Divinia** has left Ling-Temco-Vought in Texas after eight years and is now with Beech Aircraft's Missile Systems Division in Wichita, Kan. . . . **L. R. Lindenmeyer** informs us that he is now happily married with two children and working for Baltimore Gas and Electric Co. as an Operations Research Analyst, after receiving his M.S.E.E. from Southern Methodist University and his M.B.A. from Texas Christian University in 1970. . . . Congratulations are in order for **George E. Sinclair**, who received his Ph.D. in Mathematics at the University of Arizona. He is presently a temporary instructor in

the Mathematics Department while he is looking for a more permanent position. The Sinclairs have two children, a daughter, 3 and a boy, 1 and were expecting their third child in December. Meanwhile, he is continuing his work and publications in finitely additive theory. . . . Another of our classmates now in print is **Donald Dible**. His book, *Up Your Own Organization*, subtitled "A Handbook for the Employed, the Unemployed, and the Self-Employed on How to Start and Finance a New Business," has been reviewed and endorsed by the National Federation of Independent Business, Inc., and is published by The Entrepreneur Press, Santa Clara, California, which was founded by Mr. Dible. . . . From 1966 to 1970, **John E. LaGraff** was a Research Fellow at Oxford University in England. On receiving his Doctorate from Oxford in 1970, he returned to the States where he is now Assistant Professor of Mechanical and Aerospace Engineering at Syracuse University.

Having just recently joined Public Technology, Inc., as a Project Manager, **Roger Rowe** tells us that Public Technology, Inc. was created by organizations representing state and local governments to hasten the development and production of new technological products for municipalities. . . . **Jeremy E. Alperin**, M.D., will finish his residency in Ear, Nose, and Throat, at University Hospitals of Cleveland in June, 1973. . . . Wedding bells rang on November 12, 1972, for **Steven J. Brams** and the former Eva Floderer from Vienna, Austria. Mr. Brams is presently an Associate Professor of Politics at New York University and is also teaching part-time at the University of Rochester. Our best wishes to the happy couple.—**Gerald L. Katell**, Secretary, 122 North Maple Dr., Beverly Hills, Calif.

## 64

News this month is very sparse. Warm your fingers over the fire and write! **Charlie Benet** has moved to Edmonton, Alberta, to work as a senior systems analyst with the University of Alberta. He reports that the summers there are practically nonexistent. . . . **Kenneth Brecher** has been appointed as Assistant Professor of Physics at M.I.T. . . . **James Dorr** ran unsuccessfully (third of six) for the Indiana State Assembly in last spring's Democratic primary. He served as Media Director for his county's Democratic organization in the presidential campaign, and is a leader in two local civic groups. . . . **Jonathan Gross** has been awarded an Alfred P. Sloan Research Fellowship in mathematics and an I.B.M. Postdoctoral Fellowship in mathematical sciences. . . . **Robert Mehrabian** has been promoted from Research Associate to Assistant Professor in the Department of Metallurgy and Materials Science at M.I.T. . . . **Bernard Morris** is working at Bell Laboratories on research and development in semiconductor materials. His second child, a son, was born last September. . . . **Lawrence Rabiner** is also at Bell Labs, working as a supervisor in the acoustics research department. Larry is also Associate Editor of I.E.E.E. *Trans-*

actions on Audio and Electroacoustics. He and his wife Suzanne have one daughter and a second child is on the way. . . . **Donald Reed** is Chief Geologist and Vice President of Haley and Aldrich, Inc., consulting soil engineers in Cambridge.

That's it. Please write for the continuation of '64 news.—**Ron Gilman**, Secretary, 5209 Peg Lane, Memphis, Tenn. 38117

## 65

Disorganization finally caught up with me and I missed last month's deadline. In a word, sorry about that, but at least the notes and clippings have had a chance to build up. **Bill Pike** sent a letter "after being unpublished for seven years." Following graduation, Bill went to Columbia Business School for an M.B.A. (Bill thinks he has the distinction of being the first A.E.Pi ever to be refused admission to the Harvard Business School.) For the next four years, Bill was a securities analyst for one of Boston's larger banks. In October, 1971, he quit his job for a year of rest and relaxation, climaxed by a three-month trip around the world. Bill is now back in Boston seeking a job, an apartment, and a girl friend, in reverse order.

**Chuck Seniawski** (still with the air force in Dayton) and wife Sue announce the birth of a daughter, Barbara Lynn, on October 16, 1972. . . . Jan and **Jim Wolf** have a son, James Alton Wolf, Jr. (known as Josh), born on September 9, 1972. The Wolfs report that parenthood is really super. . . . **Eric Westerfeld** reports that he, wife JoAnn, and daughter Alisha are living in Santa Monica, Calif. Eric is a product manager with Computer Sciences Corp. . . . Finally, one of the few remaining bachelors is no more. That's right folks, on October 7, 1972, **Art Bushkin** was married to the former Kathryn Ann Fitchey. Art says that with someone to support him, he can devote full time to the non-lucrative enterprise of writing—the same book.

**Bruce Morrison** spent last summer in New York City working for the National Resources Defense Council, an environmental public interest law firm. Bruce is now in his third year at Yale Law School and works part-time for New Haven Legal Assistance. He plans to go into poverty or public-interest law after graduation. . . . **Jim Hester** is still in New York City, but now working with the Health Service Administration, trying to keep people healthy rather than his original job of trying to keep their housing from disappearing. Jim and Suzanne are still dating (two years now) but have no firm plans yet. . . . **Jon Hanson** has become a Sales Representative for Hooker Chemical, covering Oregon, Idaho, and southwest Washington. . . . **Ron Smith** has started Optical Consulting Services this year. He also plans to participate in the formation of a small company which will wave solder printed circuit boards and do light mechanical assembly.

**Chico Gholz** finished his two-year clerkship at the Court of Customs and Patent Appeals in September, and went to work

for a Washington law firm specializing in patent and trademark law. . . . **Patric Dawe** is working in Denver for the Philadelphia firm of Wallace, McHarg, Roberts, and Todd. He is working on a regional transportation plan for the Denver district. Pat's firm is responsible for ecological and regional planning, urban design, and architectural design for the transportation system. . . . **John Proctor** has left his job at Pontiac Division of General Motors and is getting a Master of Arts in Teaching (Religion) from the University of San Francisco. . . . **Michael White** has been appointed a lecturer in political science at Syracuse University.

**Dave Carrier** was one of four co-recipients of the Norman Medal of the American Society of Civil Engineers last October. Dave was cited for his work on lunar soil mechanics at the N.A.S.A. Manned Spacecraft Center. The Norman Medal is A.S.C.E.'s oldest and most prestigious award. . . . **Dan Diamond** was on the steering committee for last October's Sloan School Convocation at Tech. . . . **John Currano** will be attending a group theory symposium at the University of Warwick, Coventry, England, from February through August, 1973. . . . And **Pat Winston** won the Carlton E. Tucker award of the M.I.T. Department of Electrical Engineering for developing the undergraduate subject "Introduction to Artificial Intelligence." Pat is Assistant Professor of Electrical Engineering.

**Peter Klock** is writing his Ph.D. thesis at Johns Hopkins in Baltimore. His wife Susan has started law school at the University of Maryland. . . . **Mary Coffey** is working on her doctoral thesis on air pollution at the Harvard School of Public Health. . . . **Steve Deutsch** is in his second year and on the staff of the Law Review at Harvard Law School. Steve reports that his wife Karen and daughter Nancy are both fine.

**Bill Roeseler** is interested in corresponding with other alumni who may be interested in high-performance recreational sailing craft. . . . I ran into **Dick Polis** at MITRE today. Dick was with our Washington office for several years and is now Director of the site office serving Denver and Colorado Springs. . . . **Leo Rotenberg** attended a conference on "Privacy and Protection in Computer Operating Systems" at Princeton last June. Leo was impressed with the ease of "breaking" systems and comments on the prospect of 1984 arriving early in the computer realm. Leo and I have been exchanging notes on the subject via the interuser mail facility of M.I.T.'s Multics computer system. . . . and **Craig Wheeler** wonders why none of his previous alumni fund envelope notes have appeared in the column. I don't know, Craig. I print everything I can get my hands on.—**Steve Lipner**, Secretary, 3703 Stearns Hill Rd., Waltham, Mass. 02154

## 66

As I write, Boston is getting its first real taste of winter. For six months I have been preparing for a spectacular ski season, but I'm not sure I'm ready.

After the flood of news last month, I

still have some catching up to do. **Tim Carney** writes, "After an enjoyable stay with June and **Dan Allen**, both of whom are enjoying Southern California and their two children, I flew west. I arrived in Phnom Penh, May 31, via a pleasureable week in Hong Kong and a day looking up old friends in Saigon. Phnom Penh is still a beautiful city; the flame trees were in bloom in May and it took a while to notice the barbed wire near the Wat Phnom (the hill or phnom after which the city is named) and the sandbags around the treasures from Angkor at the National Museum." Tim answered a question from an earlier column.—**Lesotho** is a small country totally surrounded by South Africa and was formerly called Basutoland.

**Aaron Snyder** has also spent a great deal of time traveling. He writes that his work with Philco-Ford sent him to such far-flung places as Hawaii, the Philippines, Kwajalein, Italy, Vietnam, and Japan. He continues, "Have now settled down again to the dullness of the Delaware valley and am trying to finish my master's degree before the seven-year limit finishes it for me." . . . **Nicholas Maroulis** is currently in Japan for the construction and delivery of three vessels for the shipping company N.J. Goulandris. After Japan he intends to return to London.

A number of classmates are on the West Coast (all the smart ones). **Jon Meads** writes: "I have moved out to the wilds of Oregon where I have acquired a one-acre farm. I am breaking ponies and raising rabbits (that shouldn't be difficult), chickens, and two boys. I also have been playing wing forward for the Portland Rugby Club. In my spare time I have been working with computers." . . . **Alan Tobey** is a doctoral student at the Graduate Theological Union at Berkeley. His main interest is religion and cultural change. At the moment he is doing research on the Kundalini Yoga movement in the Bay Area. . . . **Tim Connelly** married the former Roberta Rosenberg of Oakland, Calif., last year. He left Lockheed in January to help start a new company, Fintec, which is making medical electronic instruments. . . . **Hal Helfand** is in the Bay Area also. He writes that he is now working in a dynamic simulation group at Bechtel. Their last two projects were a simulation of U.S. activities in

Classes '60, '61, '62, '64, '65, '66

## MINI-REUNION

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of class notes **NOW!**

Antartica and a simulation of a proposed U.S. Post Office bulk mail handling facility. . . . **Tom Grover** writes from Utah, "I am designing patient monitoring equipment for Utah Biomedical Test Lab. Utah skiing, climbing, and river running are superb. Social and entertainment prospects are mediocre." . . . **Tom Percer** finished four years of Medical School at U.C.L.A. and is now finishing up a pediatric residency at Orange County Medical Center. He was married late this summer to Judith Ann Suedkamp. . . . **John Postas** received his M.B.A. from Stanford and is now a computer systems consultant.

Moving back across the country. **Richard Cockerill** was married in August to the former Becky Crowner of Yampa, Colo. They are making their home in Washington where Richard is employed as an electronics engineer by the Navy Department. . . . **Peter Lobban** and his wife moved to Toronto for post-doctoral work after completing a Ph.D. at Stanford in Biochemistry. "Toronto is fortunately far less crime-ridden than U.S. cities so our stay is pleasant so far." . . . **Wayne Stevens** writes "I am with I.B.M. in Hartford as a Systems Engineer. Our daughter, Wendy Parker, was born this past summer." . . . **George H. Bourrie** is working on his doctorate in biomedical engineering at Drexel. He is doing substitute teaching in science and math to pay tuition. He is now married and his wife, the former Isabelle Lockwood, is working at Penn Mutual as a programmer. . . . **Gerry Lichtenberger** is working at the Bell Laboratories in Whippany, N.J., as a member of the Ocean Systems Research Department. He has been enjoying many ski trips with Bell Labs Club.

In closing—from a press release issued by the mayors office in Boston, "Mayor Kevin White today announced a new economic stimulation program for the city of Boston. The new program will be directed by **George R. Berbeco**, formerly an investment entrepreneur and consultant in the Boston area."

I will be skiing this vacation with several other members of the Class, **John Freeman**, **Mike Kinkead**, **Franz Birkner**, **Steve Taylor**, and **Jim Schwarzrock**, so the next issue should have some additional news. See you then!—**Tom Jones**, 59 Commercial Wharf, Boston, Mass. 02110

## 67

I dropped in on **Fred Goldman** when I was in San Francisco recently. My timing was perfect—Mrs. Goldman had just arrived from Boston with fresh lobster. Naturally, I managed to get myself invited to the feast, and we had a very pleasant evening. Fred was on vacation between jobs; I will write later about his new work. . . . **Dr. Lutz Henckels** received his Sc.D. in computer science from M.I.T. in September, 1971, and is now working at General Radio Co., in West Concord. Lutz and Patricia have their first child, Jeffrey. . . . **Robert Hardt** is Assistant Professor in Math at University of Minnesota. . . . **George Stark-schall** spent the summer sight-seeing and

visiting friends in Israel, Italy, and Spain. He returned to Cambridge long enough to play sarrusophone ("which looks and sounds like the offspring of a tenor sax and a contrabassoon"—*Boston Globe*, Aug. 7, 1972) for the Boston Summer Opera Theatre. George is now doing research in theoretical chemistry at Chicago. . . . **Dave Garbin** is working on his M.S. degree in electrical engineering at M.I.T. . . . **Donald Davis** is Assistant Professor of Mathematics at Northwestern and has a daughter, Joelle, age 2. . . . **Jim Duclos** is an Assistant Professor at Worcester Polytechnic Institute. . . . **Fred Solomon**, having received a Ph.D. in mathematics from Cornell, has become an Assistant Professor in Math at Swarthmore.

**Peggy Jones** recently began a new job in the Comptroller's Office of Time, Inc., in New York. She was previously with Colgate-Palmolive. Between jobs, Peggy spent three enjoyable weeks in Scandinavia. . . . **John Patterson** married Suzanne Brown of Silver Spring, Md., and finished his two-year tour in Washington. He will be at Roosevelt Roads, flying the A-4 Skyhawk for the next three years. He expects to enjoy the tour as the weather in Puerto Rico is always good. . . . **Charles Marantz** is again working on his M.B.A. at Harvard after spending the summer traveling around the world. He hit 22 countries in Europe and Asia. That certainly beats M.B.A. studies. . . . **Don Oestreich** has his Ph.D. in computer science from Utah. He was divorced in March, 1972, and he married Joy Zissler of Oakland, April 1, 1972. They live in Malibu Canyon and have a four-year-old son named Schany. . . . **Guillermo Arnaud** is with the Office of Telecommunications of the Department of Commerce in Washington. He is trying to catch up with everything he missed while he was in the army.—**Jim Swanson**, 508 Thompson Ave., Mountain View, Calif. 94040

## 68

Winter has now descended over the D.C. area, but it really is significantly warmer here than in Massachusetts. So far we have had no significant snow, which is good news for everyone but skiers. We have been doing a lot of business traveling in the past month: I've been to Dallas and Chicago and Gail has been to Omaha and Colorado Springs. For those of you who like mystery stories, we start off this month's news with:

### The Case of the Mysterious Rat

Someone has lost a '68 brass rat with the initials "G.P.A." at Hilton Head Island, S.C. No mystery would be involved except that M.I.T. has no record of anyone with those initials in our Class. We have searched our unofficial archives and cannot find a record of such an individual. Since the lettering on these rings is sometimes hard to read, the initials may really be something else. The person who found the ring gave it to Mrs. Dorothy Herron, 1566 Griffith Dr., Orangebury, S.C. 29115 whose husband, Lawrence, was in the Class of '65. The real G.P.A. may claim the rat by writing to Mrs.

Herron.

The bachelors that are left are getting snapped up at a slow but steady rate. **Doug Goodman** married the former Barb Eason (Duke '72) in May. He is now Associate Professor of Economics at Jacksonville State University, Jacksonville, Ala., where they are living. . . . On December 18, 1971, **Donald Bruns** was wed to Marian Edwards (Mt. Holyoke '68). Don reports that he worked with North American Rockwell in L.A. in 1968-70 and received an M.S. in Management Sciences from U.S.C. in 1970. He then worked for Drake Sheahan/Stewart Dougall, management consultants, in New York until June 1972. He now works in Chicago for Martin Brower Co., a fast food franchise distributor which is a subsidiary of Clorox. . . . **Jay Sinnett** writes that he married the former Pamela Hudson on June 10, 1972. She is a nursing student at Northern Virginia Community College. Jay has been working in the methods standardization branch of E.P.A. for a year, and has also been active in a local barbershop harmony organization. They live in Alexandria, Va.

Captain **Steve Richards** was awarded the Vietnamese Cross of Gallantry for his service while assigned to Phu Cat A.B., Vietnam. He is now a T-39 pilot at Hill, A.F.B., Utah. . . . Captain **Gary Johnson** is also at scenic Hill A.F.B. where he is a Minuteman missile test engineer. Gary serves as cubmaster for the base Cub Scout pack. . . . We received a long letter from **Frank Sheeman** who has had a varied experience in the army. After leaving in April 1967 he joined the army and served as a legal clerk (P.F.C.) in Wildflecken, Germany. After O.C.S. at Ft. Belvoir he spent a year in Thailand as a recon officer, liaison officer, and road building construction officer. Returning to Belvoir, he married a nurse named Diane four days before going to Vietnam. After nine more months of a course at Belvoir, he has returned to the 'tute, of all places, where he hopes to graduate in Course I this year. He reports a big incentive to get good grades—those with bad grades get the worst assignments, and the army has some gems. . . . But remember, military service need not last forever. **Paul Forbes** reports that he was released from the navy, as a Lieutenant Junior Grade, the end of November after spending eight months at Diego Garcia, British Indian Ocean Territory, the site of a future communications station. While not having any immediate job prospects, he is looking forward to a long-awaited, easy-going, trip around the Globe.

**Dennis Sager** is finishing his thesis for an S.M. in Course XVI and plans to return to MITRE's Washington branch when done. . . . **Dan Green** is a fourth-year medical student at St. Louis University. . . . Former class hero **Dan Harris** reports that he is almost completely recovered from his broken back and is an instructor in chemistry at Caltech. He is looking for a faculty position next year. His wife, Sally, is expecting their first child in April. . . . **Richard Borken** completed all requirements for a Ph.D. in Physics in September and will receive the degree this month. He is now a Postdoc in the Space Physics Group at the University of

Wisconsin. . . . **John Vitek** hopes to finish his doctorate in Course III this term. John adds that their 2-year-old son keeps Marty and him pretty busy. . . . Also at the 'tute hoping to finish this term is **George Phillis**. He is in the Physics Department studying light scattering and diffusion in concentrated protein solution. . . . **Bob Petkun** is finishing up at Harvard B. School. He says he is looking forward to rejoining the work force and raising his standard of living above that of student subsistence. Both he and **Robert Benveniste** were awarded First-Year Honors.

From Ithaca **Fredda Cole** writes that she is working as a systems engineer with New York State Electric and Gas Corp. Her husband, Frank, is on a fellowship at Cornell. They spend their spare time seeing the highways, byways, and backroads of western New York on their motorcycles. . . . **Scott Armstrong** is Associate Professor of Marketing at the Wharton School, University of Pennsylvania. He is in the final stages of a book, *Long-Range Forecasting*, to be published by Praeger late this year. The book deals with the use of forecasting methods in the social sciences. . . . **Steve Sydoriak** has rejoined the Physics Division at Los Alamos after being with N.O.A.A. in Boulder, Colo., for a while. . . . After receiving a master's in Civil Engineering in June, **Carl Martland** decided to stay on the M.I.T. staff to study rail-freight transportation. He spent last July and August camping and hiking throughout the West. Carl included the following cryptic comment. "**Dave Ogyrdziak** makes better popcorn than he plays chess." . . . **Tom James** reports that Shell Oil recently transferred him to New Orleans as a field engineer. He bought a house in the suburb of Kenner and says that the children, dog, his wife and himself like it. . . . **Ken Hawes** is back in Boston living on Marlborough Street and teaching Math and Science at Roxbury Latin School, which happens to be the *alma mater* of your Class Secretary. . . . Also teaching math is **Bob Jacobus** who is at Concord School, Sanridgebury, St. Albans, Hertshire, England. He and his wife, Caroline, spent the summer sight-seeing in Europe. . . . From Cambridge, **Leonard Schrank** reports that his firm, Dynamics Associates, is doing well in its third year.

That's about all we have this month. Remember that our 5th Reunion—it really is that long—will be coming up in June. Hope to see you there.—**Gail and Mike Marcus**, Class Secretaries, 2207 Reddfield Dr., Falls Church, Va. 22043

## 70

Fellow classmates, there comes a time in the life of every column when its source of vitality weakens. We would appreciate any letters or postcards filled with choice news.

We have a few short notes on students pursuing advanced education. **Fred Camplin** is studying law at Queen's University in Kingston, Ontario. His extra time is absorbed by being a tutor and legal aid work. . . . **Stephen Cohen** was

awarded First Year Honors at Harvard Business School. Before entering Harvard he was employed by Computer Catalogs, Inc. . . . Similar business school honors were gained by **Gregory Palm**. Gregory is enrolled in the Harvard joint law and business degrees program.

Now, for those in gainful employment: **Bob Jones** is working as a city regional planner in Orange County and "loving it." He relates that he is working with another alumnus, George Kurilko (Ph.D. '69). Bob is also playing with his Blue Ridge Mountain Boys and working TV, radio, clubs, and concerts. . . . Another active classmate, **Dave Luchaco**, is rapidly improving his chess game and building a motorcycle and radio controlled airplane. Dave talks to **Paul Granek** (living in Ann Arbor) a lot since Dave is residing in Rochester, Mich. He had worked in Elmira, N.Y., with Bendix Electronic Fuel Injection Division for over a year and left just two days before the big flood. . . . **Joseph Kubit** moved in a westerly direction also, going from New York City to Los Angeles when A.R.C.O. moved their headquarters. His interesting work involved financial analysis in the Treasury-Finance Department. Note the following change—Hoderowski to Howard. That's now **Stanley Howard** of Harvard Business School fame and presently associated with Cyphernetics Corp., in New York City as an account executive.

Finally, the first semester has closed here at the law school and the second is in full swing. My wife Penelope and I enjoyed a few weeks in the East between semesters, renewing acquaintances and skiing. Waiting to hear from some of you.—Co-Secretaries **Robert Vegeler**, 800 N. Smith Rd., Apt. 7-W, Bloomington, Ind. 47401; **Laura Malin**, 406 Beacon St. Apt. 1, Boston, Ma. 02115

## 71

We hope you had happy holidays. We're in Princeton with our two cats and our rapidly growing three-month-old St. Bernard. On with this month's Class Notes.

*In school:* **Richard Stat** is currently taking the M.B.A. program at Wharton Graduate School (University of Pennsylvania), to be completed in December, 1972. . . . **George W. Gawrys** is attending the Johns Hopkins University in a Ph.D. program in Electrical Engineering. His wife Nancy is attending the Johnston School of Practical Nursing, hoping to become an L.P.N. by June 1973. . . . **David B. Rhoads** wrote, "Next fall (1972) I will be attending the University of Chicago's Ph.D. program in biophysics. My wife Lynn will be entering the English literature department there for a master's." . . . **Howard L. Siegel** is presently in his second year at Boston University School of Law. He married Barbara Greenberg (Fisher Junior College, Boston University) on August 20, '72, in the M.I.T. Chapel. . . . **Jeff Follins** "will be returning to the 'tute in fall ('72) to study towards an S.M. in Project Management (C.E.); just finished teaching experimental course in 'Computation and Analysis for Architects'

at Georgia Tech, where I am trying to develop a computer library for the School of Architecture." . . . **Jonathan Lukoff** is in the Downstate Medical School, class of '76. . . . **Harold M. Ting** wrote, "I am now a graduate student in the Engineering-Economic Systems Department at Stanford. In April of this year, (1972) I was recipient of the first prize for student papers at the Nineteenth International Meeting of the Institute of Management Sciences." . . . Lieutenant **Eric A. Kraemer** is currently attending Yale Graduate School, with U.S. Army support, and working toward a master's in International Relations, hopefully to be received in June, 1973.

**Grethe (Zink) Holby** has designed and was chief carpenter for the new Tempura Hut, a Japanese restaurant in Cambridge which opened this past June. She is still at M.I.T. completing her master's in Architecture. . . . **Neal Satten** is at Harvard Med School. . . . **Laura Middleton Jackson** is doing work towards a Ph.D. in biochemistry at Maryland. Last spring, she and her husband were visited by **Janet A. Sweetman** and her husband Eric, '68, en route from Germany to Oregon. . . . **Daniel Weinberg** is working toward a Ph.D. in economics at Yale University. He's engaged to Page Laws, '73, of Wellesley College. . . . We received two "releases" from the Harvard Business School: Flash! "Boston, Mass.—**Randolph B. Hawthorne** has been awarded First-Year Honors at Harvard Business School. He plans to receive the M.B.A. degree in June and **Fred A. Middleton, Jr.**, has been awarded First-Year Honors at Harvard Business School. He is in the second year of the two-year program that leads to the Master in Business Administration degree."

**Bruce Rummel** is a grad student at the University of Washington, where he's T.A. for a course in oceanography (even though he's never taken any Courses in oceanography.) He is bicycling and apparently spending a lot of time studying. . . . **Gary Gibian** is in his second year of graduate study at Washington University, in physics. He hopes to pass his qualifying exam in January. He worked last summer at the Central Institute for the Deaf in St. Louis, building an integrated circuit data processor.

*Working:* **Dale R. Geiger** has finished M.S. programs in both Management Sci-

Classes '67, '70, '71

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ence and Metallurgy and Materials Science at M.I.T., June 1972. He wrote: "Patent applications made on Metallurgy thesis. Have wife, Liz, and son, Dale Jr. Accepted job with Corning Glass in Kentucky." . . . **Keith Price** wrote: "The coal mine has been pretty slow the past year. Hopefully next summer I'll be able to be in the California bay area. Western Pennsylvania is not the best place to spend the summer (or winter as far as that goes.) For anyone who is interested, Western Pennsylvania has the worst roads in the country; like Boston drivers, they are in a class by themselves." . . . We also heard from **Duane F. Martin**, who said: "I am now Project Engineer to design and construct two 1140MWe nuclear generating units at San Anofre near San Clemente, Calif." . . . We got a note from **Steve Shields** and **Janet Stevens Shields** saying: "We're alive and well—married August '71 in Sequoia National Park, now living in San Diego. Steve is doing grad work in physics at University of California, San Diego—working in low temperature. Janet is actually out in the world—studying visibility in the atmosphere. Both of us are playing clarinet a lot."

**Gary Lantner** is Assistant to the Director of Aviation, Mass. Port Authority, and is attending evening law school at Suffolk University while working part time for American Airlines. He and his wife Janet, '72, travelled to the South Pacific twice, visiting Hawaii, Australia, and the Fiji Islands. . . . **Mitchell Serota** received his master's degree in History from the University of Chicago.

We can still use people to work on the Kent State Memorial Lecture Series. Please write to us if you're interested. Interested or not, please write to us and Let us know what you're doing so we can put it in the '71 column. We will also accept jokes and riddles!—**Howard Jay Siegel** and **Leah Jamiecon Siegel**, Class Officers, 228C Harrison St., Princeton, N.J. 08540

**72**

It is nice to be able to report that the course evaluation project which our Class started last year along with T.C.A. is being continued, the Class of '73 having taken our role.

**Alan Downing** was the recipient of a

national Scholastic Achievement Award given by Recording for the Blind, Inc., at a White House ceremony in Washington recently. Alan is working this year at InterMetrics in Cambridge and plans to return to the Institute for graduate work next year. . . . **Alfred Morgan** writes, "I am currently serving as warden (i.e. houseparent) in Erdman Hall, Bryn Mawr College with my wife, Susan. I am a first-year graduate student in American History there." . . . **James Hogan** reports, "I am employed as a transportation planner with the Metropolitan Washington Council of Governments. My current work activity involves the sensitivity testing of a mode split model. The objective is to determine what policy options (changes in L.O.S., parking fees, transit fares) will significantly improve air quality in Washington." . . . **Rob Slutz** was married last summer to Nancy Cook, '73. They are living in Westgate and are both in Course II. . . . **Marjorie Kaplan** is at the Harvard School of Dental Medicine.

As you can see, the news this month is rather sparse. I hope that some of you that we haven't heard from will send a short note about what you are doing now that you are (hopefully) more or less settled into grad school, employment, or random hacking. If you don't feel up to writing a letter, just scrawl a postcard.—**Dick Fletcher**, Secretary, 135 West St., Braintree, Mass. 02184

**MINI-REUNION EARLY REGISTRATION**

Return to: Massachusetts Institute of Technology  
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Cambridge, Massachusetts 02139

My spouse ☐ and I ☐ plan to attend a MINI-REUNION cocktail party of the Class of ☐ on campus Sunday, June 3, 1973, from 5:00-6:00 pm. Please sign me up as definite ☐ tentative ☐. I understand the cost will be \$3.00 per person. My check is enclosed for \$6.00 ☐ \$3.00 ☐. I plan to prepay with my Alumni Day Registration ☐.

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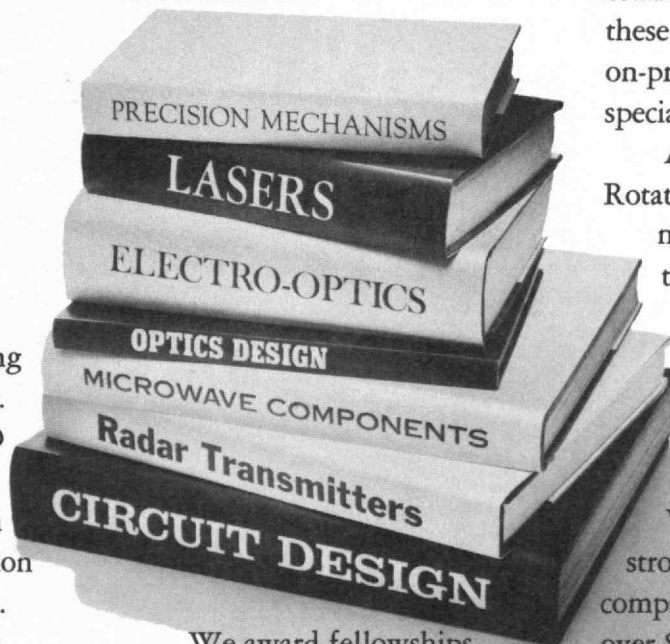
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